INSTITIÚID ARD-LÉINN BHAILE ÁTHA CLIATH
(Dublin Institute for Advanced Studies)

ANNUAL REPORT
1992

P.N. 0632

INSTITIÚID ARD-LÉINN BHAILE ÁTHA CLIATH
Dublin Institute for Advanced Studies

Annual Report of the work of the
Institute and its Constituent Schools
presented by the Council to the
Minister for Education in respect of
the year ended 31 December 1992

P.N. 0632

INSTITIÚID ARD-LÉINN BHAILE ÁTHA CLIATH
Dublin Institute for Advanced Studies

Summary of Annual Report
of the work of the Constituent Schools
for the year ended 31 December 1992

School of Celtic Studies

The primary statutory function of the School of Celtic Studies is, through its own internal projects and through its general editing of work submitted by external scholars, to investigate and publish the texts and records which are preserved in manuscripts in Irish, and also to publish analyses and descriptions of all varieties of the Irish language itself [Act 5(1), (a) - (f)].

In fulfilment of this responsibility, the School in 1992 continued its project work in the fields of manuscript studies, lexicography, Early Irish law-texts, and bibliography of Irish linguistics and literature (section 2.1). It also carried out extensive general editing on submitted work (section 2.2). No item of this work reached publication stage during 1992. For items published, see section 3.

The School also organized a good number of Celtic Studies events [Act 5 (1), (h)], and the number and background of the overseas scholars who availed of its facilities are a continuing measure of the School's effective performance as a resource centre for Celtic Studies [Act 5 (1) (i)].

School of Theoretical Physics

Thirty-nine research workers from the universities or other institutes of research or higher education (mainly in Ireland) were admitted as Research Associates of the School; forty-one scientists from abroad visited the School during the year.

Mathematical symposia were held at Easter and at Christmas; thirty-one seminars were held at DIAS and joint seminars with other third level institutions took place. Members of the School gave fifteen lectures in Ireland. The statutory public lecture was given at Trinity College by Professor A. Verbeure (Leuven).

The primary areas of research were theoretical particle physics and statistical mechanics, members of the School published papers in scientific journals and conference proceedings; they participated in fifty-four conferences abroad.

School of Cosmic Physics

The Head of the Astronomy Section, Professor P.A. Wayman, retired on 31 October 1992 after almost 30 years as Senior Professor. While he will be remembered for many different aspects of his work, perhaps one of the more significant was the negotiation of the La Palma agreement giving Irish astronomers access to modern facilities, and excellent viewing conditions in the Canary Islands.

There was an active research programme in the School during the year. In the Geophysics Section important results came from two of the main projects. As a result of the RAPIDS project in the northeastern Atlantic, it is now clear that the commonly accepted model of geological development in the region must be changed. One of the significant conclusions is that the petroliferous basin margins are not as disturbed by igneous intrusions as previously thought. In the Kenya Rift, the development and use of a unified explosion source magnitude scale has led to the measurement of very high attenuation in the Rift crust though, surprisingly, since a large mantle plume is believed to be present, the mantle underneath appears to be "normal". In the Cosmic Ray Section one of the more interesting results was the prediction of potentially observable γ-ray emission from supernova remnants. This may, in the near future, allow a critical experimental test of current theories of cosmic ray acceleration.

INSTITIÚID ARD-LÉINN BHAILE ÁTHA CLIATH

Dublin Institute for Advanced Studies

Annual Report of the work of the Institute
and its Constituent Schools presented by
the Council for the year ended
31 December 1992

In accordance with the provisions of Section 29 of the Institute for Advanced Studies Act, 1940 (No. 13 of 1940), the Council of the Institute has the honour to present to the Minister for Education for submission to the Government a report for the year ended 31 December 1992.

The report is presented under the following principal heads:-

I Constitution of the Council of the Institute and of the Governing Boards of the three Constituent Schools on the 31 December 1992.

II Report of the Governing Board of the School of Celtic Studies.

III Report of the Governing Board of the School of Theoretical Physics.

IV Report of the Governing Board of the School of Cosmic Physics.

1 Constitution of the Council of the Institute and of the Governing Boards of the three Constituent Schools on the 31 December 1992.

1. THE COUNCIL OF THE INSTITUTE

Chairman

T. K. Whitaker, D. Econ.Sc.

Ex-Officio Members

Patrick Masterson, M.A., Ph.D., President, University College, Dublin; Thomas N. Mitchell, M.A., Ph.D., Litt.D., L.L.D., D.Hum.L, F.R.C.P.I. (Hon.), Hon. F.R.C.S.I., M.R.I.A., Provost, Trinity College, Dublin; Aidan Clarke, M.A., Ph.D., F.T.C.D., President, Royal Irish Academy.

Members Appointed by the Governing Boards of Constituent Schools

M. Ó Murchú, M.A.(Dubl.NUI), Ph.D., M.R.I.A.; T. de Bhaldraithe, M.A., Ph.D., D.Litt., M.R.I.A.; J. T. Lewis, B.Sc., Ph.D.; A. J. McConnell, M.A., M.Sc., Sc.D., D.Sc., L.L.D., M.R.I.A., F.T.C.D. (to 5/1/92); E. F. Fahy, M.Sc., Ph.D.; L. O'C. Drury, B.A., Ph.D.

2. GOVERNING BOARD OF THE SCHOOL OF CELTIC STUDIES

Chairman

T. de Bhaldraithe, M.A., Ph.D., D.Litt., M.R.I.A.

Senior Professors

M. Ó Murchú, M.A.(Dubl.NUI), Ph.D., M.R.I.A.; P. Mac Cana, M.A., Ph.D., M.R.I.A.

Appointed Members

G. S. Mac Eoin, M.A., D.Phil., M.R.I.A.; S. Mac Mathúna, B.A., Ph.D., (Q.U.B.); M. P. Ní Chatháin, M.A., Ph.D. (Edin.); S. Ó Coileáin, M.A., Ph.D. (Harv.); P. Ó Fiannachta, M.A., M.R.I.A.; S. Ó Tuama, M.A., Ph.D.; G. Stockman, M.A., Ph.D., Dip.Ed.; G. Victory, B.A., Mus.D.; T. K. Whitaker, D.Econ.Sc., M.R.I.A.

3. GOVERNING BOARD OF THE SCHOOL OF THEORETICAL PHYSICS

Chairman

A. J. McConnell, M.A., M.Sc., Sc.D., D.Sc. L.L.D., M.R.I.A., F.T.C.D. (to 5/1/92).

Senior Professors

J. T. Lewis, B.Sc., Ph.D.; L. O'Raifeartaigh, M.Sc., Ph.D.

Appointed Members

J. C. I. Dooge, M.E., M.Sc., C.Eng., F.I.E.I., F.A.S.C.E., D.Agr.Sc.; J. N. Flavin, M.Sc., Ph.D.; M.A. Hayes, M.Sc., Ph.D., M.R.I.A.; P. Quinlan, B.E., D.Sc., M.S., Ph.D.; T. D. Spearman, M.A., Ph.D. (Cantab.) M.R.I.A., Member Academia Europaea, F.T.C.D.; S. S. Tóibín, M.Sc., Ph.D.

4. GOVERNING BOARD OF THE SCHOOL OF COSMIC PHYSICS

Chairman

E. F. Fahy, M.Sc., Ph.D.

Senior Professors

L. O'C. Drury, B.A., Ph.D.; P. A. Wayman (to 31/10/92), Ph.D., D.Sc. (Hon); A. W. B. Jacob, M.A., M.Sc., Ph.D.

Appointed Members

A. Brock, M.A., Ph.D., F.R.A.S., F.Inst.P.; D.J. Bradley, Ph.D., F.R.S., F.T.C.S., P.K. Carroll, M.Sc., D.Sc., Ph.D., F.Inst.P.; M. de Groot, Ph.D.; G. F. Imbusch, Ph.D., D.Sc., M.R.I.A.; D. J. Murphy, B.Sc., M.Sc.; V. J. McBrierty, B.Sc., M.A., Ph.D., Sc.D, C. Phys., F.Inst.P., M.R.I.A., F.T.C.D.; N. Porter, Ph.D.; D. L. Weaire, M.A. (Cantab.), Ph.D. (Cantab.), C.Phys., F.Inst.P., M.R.I.A.

5. ADMINISTRATIVE STAFF

Registrar

John Duggan, B.Sc.

Executive Officer

Mary Burke, B.A.

Finance Officer

Mary A. O'Rourke, B.A. (to 31/3/92); Eamonn Harrigan, B.Comm., H.Dip.Ed., A.C.M.A., (from 3/2/92).

Assistant Finance Officer

Angela Stubbs.

Clerks

Noreen Granahan; Helena Moynihan; Tony Broderick; Eibhlín Nic Dhonncha.

EQUALITY OF OPPORTUNITY

Council of the Dublin Institute for Advanced Studies at its meeting of 31 May 1988 formally adopted the Government's Policy statement on Equality of Opportunity between men and women on the staff of the Institute.

The Council of the Institute, recognising the importance of promoting equal opportunity, appointed its Chief Executive Officer as Employment Equality Officer (EEO) with responsibility for staff development. The EEO participates in the newly formed networks of EEOs in Semi-State bodies.

The Council supports equality of opportunity in recruitment and any vacancy advertised is open to everyone qualified irrespective of sex, sexual orientation, parental status or race, except where otherwise stated and where so otherwise stated shall be strictly in accordance with the Employment Equality Act 1977. No candidate will be discriminated against on account of physical handicap or disablement, provided that she/he can perform the job satisfactorily. Subject to Public Service practice, no discriminatory age limits will apply but the interview board will take into account ability of candidates to give effective service on appointment.

The following measures designed to promote equal opportunities have been adopted by the Council of the Institute:

1. Introduction of flexible working arrangements and job-sharing.

2. Operation of a career break facility. Three members of staff have availed of career breaks.

3. Setting up of a joint management negotiating committee; any difficulties arising from the operation of the Equal Opportunity programme may be referred to this committee.

The Institute's staff complement is 34 male and 24 female. One disabled person is employed.

POLICY STATEMENT ON SEXUAL HARASSMENT

It is the policy of the Dublin Institute for Advanced Studies to treat freedom from sexual harassment as a condition of work which an employee of either sex is entitled to enjoy and it regards sexual harassment as a breach of this policy.

The Council defines sexual harassment as any unwanted, unwelcomed and unreciprocated act, gesture or statement of a sexual nature made by one member of staff to another which is offensive or objectionable and causes discomfort, embarrassment or humiliation to the recipient or which affects or impedes the efficient discharge, in the work environment, of the recipient's duties as may be laid down by Council or the Governing Boards of the Schools. Sexual harassment, which is behaviour of an unsolicited and unwanted nature, is distinguished from normal interpersonal behaviour or exchanges which are mutually desired and welcomed.

Sexual harassment is regarded as conduct which is unbecoming and which may be subject to disciplinary action. Council appoints the Registrar who is the Employment Equality Officer as investigating officer should a complaint be made. Any alleged incident of sexual harassment should be reported immediately to the Registrar who will cause the matter alleged by the complainant to be investigated in an objective, sensitive and confidential manner. If the complainant feels for any reason that this reporting procedure is inappropriate, the established grievance procedures may be availed of. The Council, depending on the seriousness and veracity of the complaint, will cause appropriate disciplinary action to be taken should a prima facie case be established. Such disciplinary action may take the form of a verbal warning or for very serious incidents of sexual harassment or repeated harassment after warnings the question of suspension or dismissal may arise.

The Employment Equality Agency provides comprehensive advice to any person who, notwithstanding the foregoing, may wish to seek legal redress in the Labour Court in accordance with the provisions of the Employment Equality Act, 1977. The remedy provided by the Court on a successful outcome of a case will include a recommendation to the persons concerned on a specified course of action and compensation of such amount as the court thinks reasonable but not exceeding 104 weeks pay.

The Council emphasises that all complaints of sexual harassment which are brought to its attention will be dealt with objectively, promptly and in complete confidence.

Annual report of the Governing Board of the School of Celtic Studies for the year ending 31 December 1992 adopted at its meeting of 14 May 1993

Contents

1 Staff, Research Scholars, Research Associates

1.1 Staff

SENIOR PROFESSORS:

Máirtín Ó Murchú (Director of the School; with special responsibility for spoken language studies)

Proinsias Mac Cana (with special responsibility for Early Irish, Welsh, and Breton)

PROFESSORS:

Pádraig de Brún (with special responsibility for manuscript studies, and director of publishing)

Fergus Kelly (with special responsibility for Early Irish law texts, and director of events)

Rolf Baumgarten (with special responsibility for bibliography, and director of promotion)

ASSISTANT PROFESSOR:

Malachy McKenna (spoken language studies)

LIBRARIAN:

Siobhán Ní Laoire (also bibliography, and textual and sociolinguistic studies)

PUBLICATIONS OFFICER:

Michelle O Riordan (also historical studies)

RESEARCH ASSISTANTS:

Aoibheann Nic Dhonnchadha (manuscript studies and Irish medical texts)

Pádraig Ó Macháin (manuscript studies and bardic verse)

JUNIOR RESEARCH ASSISTANT:

Seán Ua Súilleabháin (lexicography)

SCHOLAR:

Máirín Ní Dhonnchadha (editorial supervision, early Irish law-texts)

SECRETARY:

Órla McMorrow

1.2 Part-time and retired Staff

PART-TIME ASSISTANT:

Nessa Ní Shéaghdha

COMPUTER CONSULTANT:

Cathair Ó Dochartaigh

OCCASIONAL ASSISTANTS:

Lorcán Mac Meanman (Library)

Catherine Rooney (Library)

Tarlach Baumgarten (Computer applications)

Emma Ryan (Publishing)

STAFF ON CAREER BREAK:

Mícheál Ó Siadhail (Assistant Professor; resigned October 1992)

RETIRED STAFF:

Brian Ó Cuív (Professor Emeritus)

1.3 Research Scholars

Joseph F. Eska (to September 1992)
Karen L. Maund (to September 1992)
Seán Ó Cearnaigh
Marc Caball (to September 1992)
Seán Duffy
Máire Ní Mhaonaigh
David Thornton

1.4 Visiting Senior Professor

Professor Donnchadh Ó Corráin (University College, Cork)

1.5 Research Associates

(year of first appointment)

Dr Gwenllian Awbery, Cardiff (1990)
Dr John Carey, Harvard University (1990)
Dr Thomas Charles-Edwards, University of Oxford (1990)
Professor Toshio Doi, Nagoya Women's University (1991)
Dr David N. Dumville, University of Cambridge (1989)
Professor D. Ellis Evans, University of Oxford (1990)
Professor D. Simon Evans, St Davids University College, Lampeter (1992)
Professor William Gillies, University of Edinburgh (1989)
Professor Geraint Gruffydd, Centre for Advanced Welsh and Celtic Studies, Aberystwyth (1989)
Professor Eric P. Hamp, University of Chicago (1989)
Professor Michael Lapidge, University of Cambridge (1988)
Professor Donald MacAulay, University of Glasgow (1989)
Professor Toshitsugu Matsuoka, Hosei University, Tokyo (1991)
Dr Martin McNamara, MSC, Milltown Institute of Theology and Philosophy (1989)
Professor Tomás Ó Concheanainn, University College, Dublin (1991)
Professor Donnchadh Ó Corráin, University College, Cork (1991)
Dr Cathair Ó Dochartaigh, University College, Bangor (1988)
Dr Pádraig Ó Néill, The University of North Carolina at Chapel Hill (1990)
Dr Brinley F. Roberts, National Library of Wales, Aberystwyth (1990)
Professor R. Mark Scowcroft, Catholic University of America (1990)
Dr Richard Sharpe, University of Oxford (1988)
Professor Robert L. Thomson, University of Leeds (1991)
Professor Calvert Watkins, Harvard University (1989)
Professor T. Arwyn Watkins, University College, Dublin (1990)

1.6 Visiting Scholars

Professor Eric P. Hamp (University of Chicago),
Dr Rolf Ködderitzsch (Universität Bonn),
Dr Morfydd E. Owen (Centre for Advanced Welsh and Celtic Studies, Aberystwyth),
Marc Schneiders, O.Praem. (University of Utrecht),
Prof Dr Johan Corthals (Universität Hamburg),
Dr Séamas Ó Direáin (Marymount College, California),
Dr David N. Dumville (University of Cambridge),
Kees Veelenturf (University of Amsterdam),
Dr Melita Cataldi (University of Turin),
Dr Arndt Wigger (Universität Wuppertal),
Dr Jürgen Uhlich (Universität Bonn),
Prof Dr Wilhelm Ott (Universität Tübingen),
Prof Gwenaël Le Duc (Université de Rennes II),
Gisbert Hemprich (Universität Freiburg),
Christophe Vielle (Bruxelles),
Dr Ann Dooley (University of Toronto),
Jacqueline Borsje (Free University of Amsterdam),
Ursula Marmé (Universität Bonn).

2 Research

The School's provision for research and publication during 1992 was, as in recent years, at its most adequate level in the fields of manuscript studies, bibliography, and early Irish law; projects also continued on medical texts and lexicography. Continuing staffing inadequacies, however, hamper the School in fulfilling its functions of publishing Irish manuscript texts and, in particular, of investigating spoken Irish for which additional resources are urgently required.

2.1 Primary project areas

- Manuscript studies continued, under the direction of Pádraig de Brún, on the *Catalogue of Irish manuscripts in the National Library of Ireland*, fascc. 13ff, by Pádraig Ó Macháin; a Catalogue of the Gaelic manuscripts of Scotland (R. Black); a Catalogue of Irish manuscripts in the Falvey Memorial Library, Villanova University, Pennsylvania (W. J. Mahon). Aoibheann Nic Dhonnchadha continued research on Early Modern Irish medical manuscripts. P. de Brún worked on the second edition of volume III of the *Catalogue of Irish manuscripts in the British Museum*.

- Rolf Baumgarten continued work on the *Bibliography of Irish linguistics and literature* for database screen user as well as conventional publication.
  Celtic studies in the Netherlands (Marc Schneiders and Kees Veelenturf) was published during the year as volume I of a new series entitled *Bibliographical studies*.
  Pádraig de Brún prepared the new edition of volume I of R. I. Best's bibliographies.
  Seán Ó Cearnaigh (Research Scholar, School of Celtic Studies) continued work on his *Bibliography of the printed material in the Irish language 1571–1700*.

- Fergus Kelly and Máirín Ní Dhonnchadha, General Editors of the *Early Irish law series*, continued to work on *Early Irish farming* and *Cáin Adomnáin* respectively, both volumes being intended for publication in that series. They expended considerable effort on submitted work.

2.2 Other research and editing

Máirtín Ó Murchú continued work on a description of West Perthshire Gaelic; work continued on the preparation for publication of the phonetic record of the Scottish Gaelic Survey.
Proinsias Mac Cana continued work on the history of Welsh syntax.
Pádraig de Brún did editorial work on *Aibidil Gaoidheilge & caiticiosma* (ed. B. Ó Cuív), and *The genealogical poem on Uí Fhiachrach by Giolla Íosa Mór Mac Fhir Bhisigh* (ed. T. Ó Concheanainn).
Rolf Baumgarten continued work on an edition of *In lebor gabála*, and on aspects of Early Irish syntax.
Malachy McKenna completed and submitted for publication his ediition of the vernacular nineteenth-century text *The spiritual rose*.
Siobhán Ní Laoire continued work (including field work) on register and stylistic variation in Modern Irish. She contributed as sub-section editor to *Field Day anthology of Irish writing* IV.
Aoibheann Nic Dhonnchadha continued research on Early Modern Irish medical writings.
Pádraig Ó Macháin continued work on Irish bardic poetry. He assisted Pádraig de Brún with publication projects.
Seán Ua Súilleabháin continued work on an edition and Irish index of Richard Plunket's Latin–Irish dictionary (1662). He made recordings of Irish speakers in the Uíbh Ráthach and Waterford Gaeltachts for the School's collection.
Brian Ó Cuív (retired) completed a draft of his edition, and subsequently revised proofs, of *Aibidil Gaoidheilge & Caiticiosma* by Seaán Ó Cearnaigh (1571). He continued work on the preparation of a catalogue of the Irish manuscripts in the Bodleian Library in Oxford.

2.3 Research Scholars' work

Joseph F. Eska did research on Celtic genetic linguistics, on The evolution of Celtic constituent configuration, and on Syntactic factors conditioning absolute and conjunct verbal flexion in Old Irish and concomitant morphophonological matters.
Seán Duffy completed his Ph. D. thesis on 'Ireland and the Irish Sea region, 1014–1318'. He worked on the revision for publication of the late Cardinal Ó Fiaich's thesis *The kingdom of Airgialla and its sub-kingdoms*.
Máire Ní Mhaonaigh continued work on *Cogad Gáedel re Gallaib*.
David Thornton continued work on Irish genealogies.

3 Publishing

As one of its statutory functions, in addition to research and publication by its own staff, the School provides for the editing and publishing of books and papers by outside scholars.
Computerised editing and typesetting was directed by Pádraig de Brún and Michelle O Riordan. Computer consultant was Dr W. G. Sullivan of University College, Dublin. Book design was under the expert guidance of Professor Bill Bolger of the National College of Art and Design.

The following items were published in 1992:

- *Celtic Studies in the Netherlands: a bibliography*, by Marc Schneiders and Kees Veelenturf. 1992. xx + 101 pp. (Bibliographical studies, 1). ISSN 0791–7414. ISBN 1–85500–156–X. Ir£10.
  A comprehensive listing of publications by Dutch scholars in the field of Celtic studies, including Hiberno-Latin, linguistics, and archaeology, from the earliest publication in 1597 (Vulcanius) up to 1990; with an Index, and a Chronological list of authors. Also an introductory essay entitled 'A historical survey'.

- *Scéala Scoil an Léinn Cheiltigh : Newsletter of the School of Celtic Studies*, ed. Rolf Baumgarten. No. 5, March 1992. 39 pp. ISSN 0790–9853. Free.
  Contains inter alia an essay on 'Roparz Hemon (1900–1990)' by Per Denez, and a listing of 'Irish studies theses 1990/91' by the Editor.

- *Bibliography of Irish philology and of printed Irish literature to 1912*, by R. I. Best. 1992 (orig. publ. by H. M. S. O. for the National Library of Ireland, 1913). xii + 339 pp. ISBN 1–85500–159–4. Ir£25.
  With Index of words, reprinted from R. I. Best, *Bibliography of Irish philology ... 1913–1941*, D. I. A. S. 1942; and additional Index of initial lines of poems. In the General index, account has been taken of the corrigenda, and the short titles of works listed under authors' names have been rearranged alphabetically.

- *Lebor na hUidre : Book of the Dun Cow*, ed. R. I. Best and Osborn Bergin. 1992 (orig. publ. by the Royal Irish Academy, 1929). xliv + 341 pp., pls. ISBN 1–85500–157–8. Ir£20.

- *Trí bior-ghaoithe an bháis*, Séathrún Céitinn do sgríobh : *The three shafts of death*, by Geoffrey Keating D. D.; ed. with introd., indexes, and glossary, by Osborn Bergin. 1992 (orig. publ. by the Royal Irish Academy, 1931). xxxii + 495 pp. ISBN 1–85500–158–6. Ir£25.

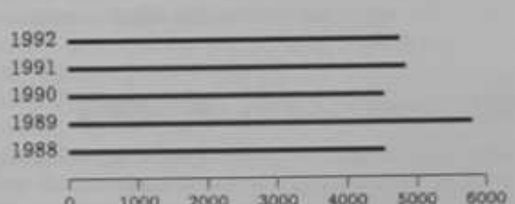
- *School of Celtic Studies: Publications in Celtic Studies, Catalogue 1992 / Scoil an Léinn Cheiltigh: Foilseacháin sa Léann Ceilteach, Catalóg 1992*. 52 pp.

The following item is now bound and distributed by the School of Celtic Studies:

Catalogue of Irish manuscripts in the Royal Irish Academy, by T. F. O'Rahilly, Kathleen Mulchrone, and others. Royal Irish Academy, 1926–1958, 1970. 27 fascc. in 6 vols + indexes (2 vols) + fasc. 28. Ir£175. – Available separately: 8 vols @ £30; fasc. 28, Ir£12.

4 Booksales

The classified and annotated catalogue of the School of Celtic Studies publications from its beginning was updated and distributed.
Promotion of publications was through advertising in *Books Ireland*, *Comhar*, *Archæology Ireland*, *Saol*, etc.
Publications by the School were exhibited in Galway on the occasion of the Joint Conference of the American Conference for Irish Studies / Canadian Association for Irish Studies (July), and in Glencolumbkille on the occasion of the Pan-European Symposium on the Celtic Languages (September), as arranged by Rolf Baumgarten, with Eibhlín Nic Dhonncha and Michelle O Riordan, and Siobhán Ní Laoire respectively.
The number of books sold during 1992 was 4755. This figure was calculated from end-of-year stocktaking figures after appropriate deduction of additions etc. during the year. The comparable figures for the preceding years were 4844 for 1991, 4533 for 1990, 5804 for 1989, 4542 for 1988. The ca. 900 copies of the *Newsletter* that have since 1987 been annually distributed world-wide have not been taken into consideration. The following chart is a projection of the above figures.



5 Library

Acquisitions policy, under the direction of Siobhán Ní Laoire (Librarian), centered on building the collection in its core areas. Some 700 new and replacement items were added. An inventory of current and discontinued periodicals was undertaken and is now complete. A programme of binding, repair binding and treatment of older materials is ongoing.

6 Events

6.1 Lectures

The Statutory Public Lecture for the year 1992 was delivered by Professor William Gillies (University of Edinburgh), on 20 November 1992, at University College Dublin, entitled 'The Book of the Dean of Lismore'.

6.2 Seminars

The following weekly seminars were conducted from 21 January to 10 March 1992:

- 'Language competence and literacy in early modern Ireland', by Dr Patricia Kelly (Royal Irish Academy).
- 'An Dubhaltach Mac Fhirbhisigh agus *Leabhar na ngenealach*: ceisteanna le freagairt', by Dr Nollaig Ó Muraíle (An Oifig Logainmneacha).
- 'Some remarks on the manuscript tradition of *Cogad Gáedel re Gallaib*', by Máire Ní Mhaonaigh (School of Celtic Studies).
- 'Adverbials as subordination in Irish', by Dr Dónall Ó Baoill (Institiúid Teangeolaíochta Éireann).
- 'Canine and lupine symbolism in *Táin bó Cúailnge*', By Ewa Sadowska (University of Warsaw).
- 'Features of the morphology of the verb in the Irish of Inis Oírr, Aran Islands', by Brian Ó Catháin (University College Dublin).
- '"Hibernia destructa per uermes"', by Dr David E. Thornton (School of Celtic Studies).
- 'An expert witness: why Adomnán needs Arculf', by Thomas O'Loughlin (Milltown Institute).

6.3 Annual Symposium / Tionól 1992

The Annual Symposium / Tionól was held on 20–21 November, incorporating as a key feature the Statutory Public Lecture. In addition, the following papers were read:

- Seán Ó Cearnaigh, 'Gné de phrós an 17ú haois: William Perkins sa Ghaeilge'.
- Rijcklof Hofman, 'The Irish Priscian manuscript in St Gall: proposals for a new edition of the glosses.'
- Máirín Ní Dhonnchadha, 'Reading the so-called *Caillech Bérri* poem.'
- Thomas O'Loughlin, 'Towards assessing the contents of the library of Iona in the late seventh century.'
- Tadhg Ó Dúshláine, 'Exempla Gaeilge ón *Vitae Patrum*.'
- Dónall Ó Baoill, '*ann*.'
- Ursula Marmé, 'The compound *tionól* and related matters.'
- Uáitéar Mac Gearailt, 'The language and style of the LL *Togail Troí*.

7 Outside activities and contributions to scholarship

7.1 Activities

Lectures were delivered by Máirtín Ó Murchú to the Clare Archaeological and Historical Society (April), at University College Aberystwyth (May), at the University of Limerick (October); Proinsias Mac Cana, 'Formalized incitement in Irish literary tradition', Medieval M.Phil. Seminar, University College Dublin (November); he was appointed a member of the Foundation for Celtic and Irish Studies of Queen's University Belfast and the University of Ulster. Brian Ó Cuív (Emeritus Professor) attended the Name Study Conference and the Annual General Meeting of the Council for Name Studies in Great Britain and Ireland, Belfast (April); he continued his activities as Chairman of the 'Corpus Apocryphorum Hiberniae Publication Project', as a member of the Irish Manuscripts Commission, and as a member of the Council of the Irish Texts Society. Malachy McKenna lectured on 'Generative phonology and morphology', Centre for Language and Communication Studies, Trinity College Dublin (March–April); Siobhán Ní Laoire, (panel speaker) 'Future of dialect studies in the Celtic languages', Pan-European Conference on the Celtic Languages (September), 'Cur i láthair na litríochta béil', Comhar na Múinteoirí Gaeilge (November); Michelle O Riordan, Cumann na Sagart, Dundalk (November); she attended the Joint Conference of the American Conference for

Irish Studies / Canadian Association for Irish Studies, Galway (July). Máirín Ní Dhonnchadha lectured on 'Images of women in medieval Irish writing', Celtic Studies Conference, Toronto (March), 'Adomnán in Ireland and Scotland', Department of Scottish Studies, University of Guelph (March), 'Slaves, mothers and Hiberno-Saxon politics in the late seventh century', Department of Celtic Studies, Harvard University (April), 'Crime and punishment in Adomnán's law and times', Dublin Medieval Society, Trinity College Dublin (April), 'Canóin na litríochta Gaeilge: Cá háit? Cia hé? Cá taobh ór ghluais?', Merriman Summer School, Lisdoonvarna (2 lectures, August), 'Gender and the poet as his lord's lover', Éigse Shliabh gCuilinn 1992 (November). She was Visiting Professor at St Michael's College, University of Toronto (January–April).

Lectures delivered by Research Scholars were Joseph F. Eska, 'On the crossroads of phonology and syntax: remarks on the origin of Vendryes' Restriction and related matters', Jesus College Oxford, 'On drinking, grammar, and orthography in ancient Gaul', Fifteenth Annual Meeting of the Celtic Studies Association of North America, St Francis Xavier University, Antogonish, Nova Scotia; Seán Duffy, 'John de Courcy and the kingship of Scotland: a forgotten connexion?', Sixth Irish Conference of Medievalists, Maynooth (June), 'Ireland and Wales in the thirteenth century', Department of Irish History, Trinity College Dublin (November); David Thornton, 'The Conaille Muirtheimne', St Patrick's College Maynooth (September); Máire Ní Mhaonaigh, 'Einige Bemerkungen zu den Verbalstammbildungen in *Cogad Gáedel re Gallaib*', Erstes Symposium deutschsprachiger Keltologen, Berlin (April), 'Mid-twelfth-century interpolations in *Cogad Gáedel re Gallaib*', Trinity College Dublin (April), 'Bréifne bias in *Cogad Gáedel re Gallaib*', University College Cork (April).

7.2 Contributions to scholarly publications

Máirtín Ó Murchú published the chapter on the Irish language in *The Celtic connection*, ed. G. Price (1992) 30–64. Proinsias Mac Cana and Rolf Baumgarten acted as (two of the three) co-editors of *Ériu*, vol. 43, 1992, to which they contributed papers entitled '*Laíded, gressacht* "ritual incitement" ' and 'Discourse markers in medieval Irish texts: *cé, cair, ní*, and similar features' respectively. Proinsias Mac Cana published a revised edition of *The Mabinogi* (Cardiff, 1992); 'The *petite patrie* in Modern Irish and Welsh literature', in *Irish University Review* 22 (1992) 13-32. Pádraig de Brún continued the publication of his 'The Irish Society's Bible teachers, 1818–27', in *Éigse* 25 (1991 [1992]) 113-49, and prepared the final instalment (Index of places) for volume 26 (1992). The latter volume will also contain 'Nóta ar Bhrian Ó Ceallaigh' by Marc Caball. Brian Ó Cuív (Emeritus Professor) published 'St Gregory and St Dunstan in a Middle-Irish poem on the origins of liturgical chant', in *St Dunstan: his life, times and cult*, ed. N. Ramsay et al. (Woodbridge, 1992) 273-93; and the Opening address to the fifth International Conference on the History of Linguistics held in University College, Galway, 1–6 September 1990, in *Diversions of Galway: papers on the history of linguistics*, ed. A. Ahlqvist (Amsterdam/Philadelphia, 1992) 1–5. Máirín Ní Dhonnchadha published reviews of R. Breatnach, *Ar muir agus ar tír* (1990), and of K. McCone and P. Ó Fiannachta, *Scéalaíocht ár sinsear* (1991), in *Comhar*, September and October 1992 respectively.

Research Scholars' publications during the year were Joseph F. Eska 'First person emphatic and imperative in Early Irish', *Bulletin of the Board of Celtic Studies* 38 (1991) 87–92; 'Further to ανδοουνναβο', *Journal of Celtic linguistics* 1 (1992) 119–25; 'A propos of Gaulish σονεμετος', *Zeitschrift für celtische Philologie* 45 (1992) 96–101; 'The treatment of IE **ō* in Hispano-Celtic and related matters', *Veleia* 7 (1990 [1992]) 157–63. Máire Ní Mhaonaigh 'Bréifne bias in *Cogad Gáedel re Gallaib*', *Ériu* 43 (1992) 135–58. David Thornton 'A neglected genealogy of Llywelyn ap Gruffydd', *Cambridge medieval Celtic studies* 24 (1992) 9–23. Marc Caball 'Some notes on an Elisabethan Kerry bardic family', *Ériu* 43 (1992) 177–92. Seán Duffy 'The continuation of Nicholas Trevet: a new source for the Bruce invasion', *Proceedings of the Royal Irish Academy* 91 C (1991 [1992]) 303–15; 'Irishmen and Islesmen in the kingdoms of Dublin and Man, 1052–1171' *Ériu* 43 (1992) 93–133. Seán Ó Cearnaigh 'Eipic Ghiolgamais in *Cuaifeach mo lon dubh bui*', *Comhar* (Lúnasa 1992) 25–30.

Annual Report of the Governing Board of the School of Theoretical Physics for the year ending 31 December 1992 adopted at its meeting on 20 December 1993.

1 Staff, Scholars and Associates

SENIOR PROFESSORS: John T. Lewis (Director from 1 January 1975), Lochlainn S. O'Raifeartaigh

LIBRARIAN: Position Vacant

SECRETARY: M. Matthews

EMERITI PROFESSORS: John L. Synge, James R. McConnell

SCHOLARS: G. da Costa (Brazil), D. McManus (Ireland) to 31 August, D. McMullan (England), D.J. O'Connor (Ireland) from 1 August, A. Patrick (Russia), P. Ruelle (Belgium), I. Tsutsui (Japan).

RESEARCH ASSOCIATES: Re-appointed to 31 December 1992:

TCD: P.S. Florides, B.K.P. Scaife, D. Weaire

UCD: P.A. Hogan, D.J. Judge, J.D. McCrea, J.V. Pulé, W. Sullivan

ST. PATRICK'S COLLEGE MAYNOOTH: B. Dolan, C. Nash, A. O'Farrell, J.A. Slevin, J. Spelman, D.H. Tchrakian

UCG: J. Burns, M.J. Conneely, M.P. Tuite, T.N. Sherry

DIT KEVIN ST: T. Garavaglia, B. Goldsmith, M.J. Tuite

DIT BOLTON ST: P. Houston

DCU: M. Barman, E. Buffet, J. Burzlaff, D. Heffernan

LIMERICK UNIV.: R.H. Critchley, J. Kinsella, B. Lenoach

CARLOW RTC: D. O Sé

CORK RTC: M. Vandyck

AN FORAS FORBARTHA: J.M. Golden

OPEN UNIVERSITY: A.I. Solomon

OXFORD UNIVERSITY: R.G. Flood, A.C. Ottewill

U.C. IRVINE: P. McGill

METEOROLOGICAL SERVICE: P. Lynch

DEPT. OF FINANCE: A.J. Curran

UNAFFILIATED: G.M. O'Brien

VISITING SCIENTISTS: V.I. Arnold (Moscow) 28 Oct., H. Asatryan (Armenia) 27 Nov. - 10 Dec., M. van den Berg (Edinburgh) 22 July - 1 August, V. Blagodatskikh (Moscow) 30 July, D. Botvich (Moscow) 15-22 May, S. Buckley (Ann Arbor) 21-23 Dec., W. Cegla (Wroclaw) 29 July - 7 August, R. Coquereaux (Marseille) 28 Oct. - 3 Nov., A.L.S. Corner (Oxford) 27-31 Mar., E. Corrigan (Durham) 8-11 Feb., T. Dorlas (Swansea) 1-4 Nov., 21-23 Dec., L. Fehér (Montreal) 10-27 Oct., G.W. Ford (Michigan) 14-28 June, 13 July - 1 Aug., V.I. Gaiduk (Moscow) 7 Nov. - 5 Dec., R. Göbel (Essen) 7-22 Mar., S. Gupta (Syracuse) 25 May, S. Hughes (Harvard) 21-23 Dec., G. Jorjadze (Tbilisi) 6-11 Nov., D. Karakhanian (Armenia) 27 Nov. - 11 Dec., M. Kelbert (Moscow) 11-31 May, 22 Nov. - 20 Dec., D. Knuth (Stanford) 16 April, M. Lavelle (Regensburg) 15-23 Jan., M. Lavelle (Mainz) 11-25 Oct., P.McGill (Irvine) 11-15 May, W. McGlinn (Notre Dame) 23 May -7 June, E.F. Misbchenko (Moscow) 30 July, M. Muldoon (Warwick) 23-30 Mar., J. Noble (Cork) 20-21 Oct., 16-18 Nov., N. O'Connell (Berkeley) 21-23 Dec., R.F. O'Connell (Louisiana) 5 June - 17 August, C. Pfister (Lausanne) 7-17 Oct., V.B. Priezzhev (Dubna) 2 May - 20 June, M. Saveliev (Lyon) 15 Sept. - 14 Oct., A.I. Solomon (Open University) 21-23 Dec., R. Sorkin (Syracuse) 27 May - 11 June, I. Soukhov (Cambridge) 6-30 Aug., 1-20 Dec., C. Stephens (Utrecht) 13-20 Feb.,15-24 July, N. Straumann (Zurich) 23-30 Sept., M.P. Tuite (Galway) 21-23 Dec., P.J. Upton (Oxford) 31 Aug. - 11 Sept., A. Verbeure (Leuven) 10-14 June, 24-27 Nov, N. Vvedenskaia (Moscow) 23 Aug. - 14 Sept., A. Wipf (Zurich) 22 Sept. - 9 Oct.

2 General

The president of Ireland accepted the resignation of Dr. A.J. McConnell as Chairman of the Board on 6 January 1992. A reception for Dr. McConnell was held on 11 March 1992 at which the President made him a presentation on behalf of the School to mark fifty two years unbroken service as a member of the Board. The Board notes with regret that the position of Chairman remained vacant throughout the year.

3 Research and Study

3.1 Theoretical Particle Physics

The main work of Prof. L. O'Raifeartaigh during the past year was carried out in association with Drs. Tsutsui and Ruelle and was concerned with the conformal reduction of Wess-Zumino-Witten(WZW) theories. In previous years the group had shown that associated with every $sl(2)$ embedding in the WZW group there was a canonical reduction which led to an integrable generalized Toda system. Furthermore, the reduction provided a full set of solutions of the generalized Toda systems and showed that their symmetry algebras were Zamolodchikov algebras (extensions of the Virasoro algebras by primary fields). The activity of the past year was concerned with investigating the exhaustivity of these results i.e. investigating whether any other linear, conformally-invariant WZNW reductions were possible. The group succeeded in showing that any linear conformally-invariant WZNW reduction required the existence of an $SL(2)$ embedding and established results which showed that although the canonical reduction associated with each such embedding was not quite unique the alternatives were very limited. In fact, the only counter-examples that have been produced so far are direct products of canonical reductions and of free-fields. This work was carried out in collaboration with L. Fehér (Montreal and Bonn University) and A. Wipf (ETH Zurich) and an extensive joint paper on the subject has been submitted for publication. In addition some progress was made on the problem of quantizating reduced WZW systems using functional integral methods.

A second field of investigation, concerns the derivation of the spin-statistics theorem from more general assumptions than are made in the context of quantum field theory, in particular from assumptions concerning the topology of any space of particles and anti-particles (or strings and anti-strings) admitting pair creation and annihilation. It has been shown that a determining factor for all of such spaces are the homology groups and that, for systems with up to three particles or anti-particles, the non-trivality of the first and second homology groups are the main factors underlying the spin-statistics theorem and the existence of closed two-forms (such as those associated with the Berry phase and topological field theory) respectively. Present work is concerned with the generalization of these results to any number of particle and anti-particles and their realization in the context of field-theory. The work is being carried out in collaboration with A. Balachandran and R. Sorkin (Syracuse) and W. McGlinn (Notre Dame) under a US NSF contract.

A third field of activity was the completion of previous work on the Aharonov-Bohm effect in collaboration with N. Straumann (Zurich Univeristy) and A. Wipf(Zurich E.T.H.). The completion concerned the effect of superconductors on the A-B effect and the role of the gauge-potential in that case.

Dr. I. Tsutsui studied the general structure of the Kac-Moody reduction to W-algebras and the related integrable models, especially the Wess-Zumino-Novikov-Witten model.

The main focus of Dr. D.J. O'Connor's research was to describe how the largescale collective effects, especially in the neighbourhood of a second order phase transition, described in terms of a field theory, change as some physical scale in the problem is modified. In collaboration with C. Nash he investigated how the global features of a manifold affect the field theory and are accessible in a field theoretic framework. He investigated also the geometrical structure behind the renormalization group.

Dr. D. McMullan with M. Lavelle studied how to extend and use new symmetries constructed in gauge theories and with I. Tsutsui analysed the structure of superselection sectors in gauge theories.

Dr G. da Costa's research was concerned with the study of certain algebras like the Temperley-Lieb, Hecke and Birman-Wenzl algebras and their association with classical lattice models in statistical mechanics.

Dr. D.H. Tchrakian continued his programme of studying the properties of the generalised Yang-Mills models both in arbitary even dimensions, and their descendent models in the physically relevant dimensions 4,3 and 2. The main effort was dedicated to the topologically stable solutions, and their application to quantum field theory. Some related work on Skyrme-like models was also carried out.

Dr. O'Brien worked on a sphaleron solution of the SO(4) generalised YM-Higgs system on R_4.

She also investigated asymptotic and numerical solutions of the instanton of the above model.

Dr. B. Dolan studied the renormalisation group, the standard model and quantum field theory in curved space-times.

Dr. C. Nash studied differential topology and quantum field theory.

3.2 Classical Statistical Mechanics

Prof. Lewis continued his investigation with Dr. Pfister (Lausanne) on large deviation principles in statistical mechanics; together with Dr. Sullivan, they began work on the equivalence of ensembles from this standpoint. Prof. Lewis and Dr. Sullivan continued work on the manuscript of a book on statistical mechanics and the thermodynamic formalism.

Professor McConnell extended his work on dielectric relaxation in collaboration with Prof. A.I. Gaiduk and Dr. Yu.P. Kalmykov (Moscow), generalizing a two-parameter relaxation theory of Burshtein and McConnell by adopting a J-diffusion model based on 3 parameters. He collaborated with Gaiduk, Tseitlin and Novscova (Moscow) in work on molecular collisions. He prepared reports on the papers of Lanczos on Dirac's equation for the centenary of the birth of Lanczos in 1993.

Dr. Patrick studied the thermodynamic properties of directed polymers on regular lattices. He studied magnetization profiles, surface tension and related properties of ferromagnets on regular lattices with inhomogeneous boundary conditions.

Dr. P. Ruelle studied the classification of modular invariant partition functions for affine Lie algebras. He studied algebraic aspects of d-dimensional Abelian sandpile models and statistical properties of one-dimensional models.

Dr. E. Buffet studied the behaviour of classical random systems at low temperature.

Dr. W. Sullivan studied the use of large deviation techniques in various interacting particle models.

Professor Scaife completed the preparation for publication of the fourth, and final, volume of the Mathematical Papers of Sir William Rowan Hamilton. He also worked on the development of a model for damping in ferromagnetic resonance.

3.3 Quantum Statistical Mechanics

Profs. Ford, Lewis and O'Connell continued their work on applications of the quantum Langevin equation to tunnelling problems under a US NSF contract.

Dr. Dorlas, Prof. Lewis and Dr. Pulé completed the preparation for publication of their work on the full diagonal model of an interacting boson gas.

3.4 Quantum Theory and Quantum Electronics

Professor Slevin collaborated with workers in UCL (London) on positron-hydrogen scattering and with workers in Université Paris-Nord on atomic beam interferometry.

Dr. Conneely studied multiply excited states of atomic systems.

Dr A.I. Solomon studied applications of groups and quantum groups to condensed matter physics and quantum optics.

3.5 General Relativity and Gravitation

Dr. M. Vandyck continued his study of space-time symmetries in supergravity. Together with D. McManus and S. Hughes he studied circular cosmic strings and their gravitational effects.

Dr. D. McManus also analysed finite thickness planar domain wall solutions. In collaboration with G. da Costa he undertook a review of path integral techniques in multiply connected spaces.

Dr. O'Brien studied axially symmetric solutions to the R-squared Gauss-Bonnet (Lovelock) gravitational model.

Dr. B. Dolan studied quantum gravity and Ashtekar's variables.

Dr. Ottewill worked on the emission of gravitational radiation by cosmic string loops. He also studied quantum superradiance around rotating black holes and negative energy fluxes and their detection.

3.6 Applied Mathematics

Dr. M. Golden studied continuum mechanics and viscoelastic boundary value problems.

Dr. E. Buffet carried out research into queueing networks.

Dr. M. Vandyck with D. Hurley investigated aspects of differential geometry and spinors as motivated by supergravity.

Dr. P. Lynch worked on the development of computer methods for numerical weather predicting and investigated initialization techniques using digital filters.

Dr. J. Burzlaff's general area of research was nonlinear partial differential equations. In particular he studied the forces between optical solitons propagating along an optical fibre, vortex-vortex scattering on superconductors and topologically nontrivial solutions of generalised Yang-Mills theories.

3.7 Pure Mathematics

Prof. A.G. O'Farrell with J. Feinstein studied approximations and extension in spaces of C^∞ functions on the plane. He studied the computation of analytic capacity with J. Feinstein and T. Dowling. He continued research into the genetics of multiple sclerosis with D. Lord and studied tangent stars with D. O'Keeffe.

Dr. B. Goldsmith investigated the impact of set and model theory on algebra, particularly in relation to Abelian group and module theory.

Dr. P. McGill concentrated his research on investigating fluctuating time-changes of real diffusions. This has applications to buffer and overflow problems for communications networks and queues.

4 Research Reports

Research work during the year was written up in the first instance in research reports. Two lists of titles of these reports (preprints) were prepared and circulated to a mailing list of approximately 350 research institutes and university departments throughout the world. As far as possible, copies of the preprints were sent out in response to requests. Many of the reports appeared later as publications (See section 9.3), or were in press at the end of the year.

DIAS-STP-92-

-01: J. McConnell: Some implications of theoretical physics for epistemology.

-02: D. O'Connor, C.R. Stephens, & F. Freire: Dimensional reduction and the non-triviality of $\lambda\phi^4$ in four dimensions at high temperature.

-03: M. Vandyck, & M. Chearnley: On a terrestrial electro-motive force induced by galactic magnetic fields.

-04: D.J. McManus: Generalised splitting of spacetime.

-05: Y.P. Kalmykov, & J. McConnell: Extended rotational diffusion and dielectric relaxation in liquid solutions.

-06: G.M. O'Brien, & D.H. Tchrakian: A non-abelian Higgs model with instantons and sphaleron.

-07: D.H. Tchrakian, & H.J.W. Müller-Kirsten: A (2+1)-dimensional model with instanton and sphaleron solutions.

-08: J. Burzlaff, A. Chakrabarti, & D.H. Tchrakian: Axially symmetric instantons in generalized Yang-Mills theory in 4p dimensions.

-09: I. Tsutsui, & L. Fehér: On the Lagrangian realization of the WZNW reductions.

-10: V.B. Priezzhev: Exact height probabilities in the abelian sandpile model.

-11: A.P. Balachandran, W.D. McGlinn, L. O'Raifeartaigh, S. Sen, & R.D. Sorkin: The spin-statistics connection from homology groups of configuration space and an Anyon Wess-Zumino term.

-12: V.I. Gaiduk, B. Tseitlin, T. Novskova, & J. McConnell: Non-vanishing molecular collision times and dielectric relaxation for linear molecules.

-13: M. Lavelle, & D. McMullan: The radiation class: a new set of temporal gauges.

-14: G. da Costa: BWμ-type algebras and lattice models.

-15: J. McConnell: Application of Krylov-Bogoliulov-Mitropolsky methods to relaxation processes.

-16: E. Buffet, & N.G. Duffield: Exponential upper bounds via martingales for multiplexers with Markovian arrivals.

-17: P. Ruelle, & S. Sen: Toppling distributions in one-dimensional abelian sandpiles.

-18: J. Burzlaff, A. Chakrabarti, & D.H. Tchrakian: Generalised self-dual Chern-Simons vortices.

-19: Brian P. Dolan: Quantum nondemolition of the universe.

-20: J.V. Pulé, & V.A. Zagrebnov: A pair Hamiltonian model of a non-ideal Boson gas.
-21: A. Patrick: On phase separation in the spherical model of a ferromagnet : quasi-average approach.
-22: Z.-Q. Ma, & D.H. Tchrakian: Wu-Yang fields.
-23: D. McMullan: Constrained quantisation, gauge fixing and the Gribov ambiguity.
-24: S.H. Hughes, D.J. McManus, & M.A. Vandyck: Weak-field gravity of circular cosmic strings.
-25: D.G.C. McKeon, & T.N. Sherry: Operator regularization and the phase of one-loop determinants.
-26: Ph. Ruelle, E. Thiran, & J. Weyers: Implications of an arithmetical symmetry of the commutant for modular invariants.
-27: J.-L. Gervais,L. O'Raifeartaigh, A.V. Razumov, & M.V. Saveliev: Gauge conditions for the constrained-WZNW-Toda reductions.
-28: T.N. Sherry, & D.H. Tchrakian: Can the electroweak model be extended to support instanton solutions?
-29: M.P. Tuite: Monstrous moonshine and the uniqueness of the moonshine module.
-30: D.J. McManus, & M.A. Vandyck: Weak-field gravity of revolving circular cosmic strings.
-31: N.G. Duffield: Rigorous bounds for queue lengths in heterogeneous ATM multiplexers.
-32: V.I. Gaiduk, B.M. Tseitlin, V.V. Gaiduk, & J.R. McConnell: The complex susceptibility of a two-potential system of reorientating polar molecules.
-33: None published.
-34: A. Patrick: The influence of external boundary conditions on the spherical model of a ferromagnet I: Magnetization profiles.
-35: D.R. Karakhanian: On holomorphic factorization of two-dimensional gravity action.
-36: D. O'Connor, & C.R. Stephens: Geometry the renormalization group and gravity.
-37: D. O'Connor, & C.R. Stephens: The renormalization group in curved spacetime.
-38: F. Freire, D. O'Connor, & C.R. Stephens: Finite temperature phase transitions in quantum field theory.
-39: C. Nash, & D. O'Connor: Ray-Singer torsion, topological field theories and Riemann Zeta function at s=3.
-40: C. Nash, & D. O'Connor: Determinants of Laplacians and the Ray Singer torsion.
-41: D. O'Connor, & C.R. Stephens: Cross-over scaling : a renormalization group approach.
-42: F. Freire, D. O'Connor, & C.R. Stephens: Finite-size scaling below T_c.
-43: D. O'Connor, & C.R. Stephens: Finite size scaling functions to two loops.
-44: Y. Kubyshin, & D. O'Connor: Decoupling of heavy fermions in the Kaluza-Klein approach.
-45: Ph. Ruelle: Automorphisms of the affine SU(3) fusion rules.
-46: L. O'Raifeartaigh, N. Straumann, & A. Wipf: Aharonov-Bohm effect in presence of superconductors.

5 Seminars, Review Lectures, Series, Courses

Seminar and review lectures, series, and courses, in specialised areas of physics and mathematics were given at DIAS-STP throughout the year, by members or visitors; as in previous years these were attended by members of staff and students from the universities and other third level research institutes in the Dublin Area, and by members of the scientific schools of DIAS.

Seminars and lectures were given also under the auspices of the Dublin Particle Theory Group by the School's members and visitors.

5.1 Statutory Public Lecture

The Statutory Public Lecture entitled *From Microphysics to Macrophysics* was delivered by Professor A. Verbeure (Leuven) on 24 November in Trinity College Dublin.

5.2 Seminar and review lectures given at DIAS-STP

- Prof. H. Asatryan (Yerevan) *The renormalization group equations and Higgs boson masses*
- Dr. M. van den Berg (Edinburgh) *Heat flow, Brownian motion and electrostatic capacity*
- Prof. V.I. Blagodatskii (Moscow) *Pontrijagin's maximum principle*

- Dr. B. Dolan (Maynooth) *Report on the Rutherford Laboratory Christmas Conference*
- Dr. L. Fehér (Montreal) *Generalized DS reductions and KdV hierarchies*
- Dr. D. Karakhanian (Yerevan) *The holomorphic factorisation of the two dimensional gravity action*
- Academician E.F. Mishchenko (Moscow) *Optimal control problems*
- Prof. P. McGill (Irvine) *Fine structure on a two-state Markov chain*
- Dr. M. Muldoon (Warwick)*Discovering the topology of phase space from experimental time series*
- Dr. J. Noble (Cork) *Large time asymptotics for evolution equation with random potential*
- Prof. C. Pfister (Lausanne) *Adiabatic evolution in quantum mechanics*
- Prof. V. de Sabbata (Bologna)*Introduction of spin in general relativity*
- Prof. M. Saveliev (Moscow) *Integrable systems* (Series of four lectures)
- Dr. Yu. Suhov (Cambridge)*Ground states of boson lattice quantum systems*
- Dr. P.J. Upton (Oxford)*The bubble model for correlation functions*
- Dr. N. Vvedenskaia (Moscow)*Algorithms for random access to broadcasting channels*
- Dr. N. Vvedenskaia (Moscow)*The inverse radon transform and tomography*

5.3 Seminars given by the Dublin Particle Theory Group in DIAS and elsewhere in Ireland

- Dr. D. Bermingham (CERN) *Algebraic structure of topological gravity*
- Dr. R. Coquereaux (Luminy/Marseille) *Yang-Mills fields and symmetry breaking: from Lie superalgebras to noncommutative geometry*
- Dr. V. Gupta (Syracuse and Rochester) *Edge currents and vertex operators in Chern-Simons theories*
- Dr. M. Lavelle (Mainz) *Axial gauges*
- Prof. W. McGlinn (Notre Dame)*Exchange rotations relationship from pair creation*
- Dr. D. McManus *Planar domain walls*
- Dr. D. McMullan *Gauge fixing and superselection sectors*
- Dr. C. Nash *Analytic torsion and 3-dimensional quantum field theories*
- Dr. A. Ottewill (Oxford) *Quantum field theory on cosmic string space times*
- Prof. L. O'Raifeartaigh *W-infinity algebras*
- Prof. R. Sorkin (Syracuse and Chicago) *New proof of positive energy in GR using focussing of null rays*
- Prof. N. Straumann (Zurich) *Black holes and all that*
- Dr. I. Tsutsui *Chiral bosons out of the WZNW theory*
- Dr. A. Wipf (ETH, Zurich) *Finite size effects from general covariance and trace anomaly*

5.4 Other lectures or seminars given in Ireland by members of the DIAS-STP

- Prof. J.T. Lewis *Thermodynamic aspects of probability theory* Waterford RTC., September.
- Prof. L. O'Raifeartaigh *Recent modifications of the Big-Bang theory* T.C.D., February.
- Prof. J.R. McConnell *Theoretical physics and epistemology* U.C.D.
- Dr. E. Buffet *Martingales and travelling waves* D.C.U., February.
- Dr. N. Duffield *Martingale exponential bound for queue lengths in multiplexers* U.C.D.,November.
- Dr. D.J. McManus *Straight facts about cosmic strings* U.C.C., February.
- Dr. D.J. McManus *Generalised space-time splitting* U.C.D., April.
- Dr. J.V. Pulé*The full diagonal model of a Bose gas* U.C.D., April.
- Prof. J. Slevin *Development of a digital speckle correlation system for use in non-destructive testing of advanced engineering ceramics* U.C.D., September.
- Dr. M. Tuite *The monster and Conway groups in string theory* U.C.D., December.

- Dr. J. Burns *The Jacobi equation and flat tori* U.C.C., April. *Riemannian geometry and group theory* Galway, May.
- Dr. M. Vandyck *Gravity from Newtonian mechanics to supergravity* Series of 3 seminars, U.C.C., April.
- Dr. P. Lynch *Geophysical Fluid Dynamics* Series of 16 Lectures, T.C.D., October-December. *Weather prediction by numerical process* Irish Meteorological Society, February.
- Dr. C. Nash Graduate lectures on stochastic integration T.C.D.
- Dr. A. Ottewill *Numerical black hole evaporation* U.C.D., October.

5.5 Seminars, Lectures and Courses given abroad

- Professor J.T. Lewis*Large deviations and the thermodynamic formalism* (Paris) *Thermodynamic aspects of large deviations* (Swansea) *Are thermodynamic concepts useful in probability theory?* (Cambridge) *Two lectures in thermodynamic concepts in probability theory* (Swansea) *Entropy and large deviations* (London) *A concise account of the thermodynamic formalism* (Oberwolfach) *The thermodynamic formalism* (Swansea) *Entropy, pressure and large deviation theory* (Oberwolfach)
- Professor L. O'Raifeartaigh*Classical interpretation of the Aharonov-Bohm effect* (Nijmegen) *Integrable systems as reductions of WZNW systems* (Lyon) *SL(2,R) reductions of WZNW systems* (Salamanca) *Toward WZW reductions at the quantum level* (Kingston) *Spin-statistics theorem and topology* (Bregenz) *Canonical WZNW-Toda reductions* (Durham) *Exhaustivity of the canonical WZNW-Toda reductions* (Cambridge)
- Prof. J.R. McConnell *Schrödinger, pages of his life and meetings with him* (Fryazino) *Erwin Schrödinger, physicist and philosopher* (Kiev)
- Dr. E. Buffet *Martingales and travelling waves* (Heriot-Watt University, Edinburgh) *Directed polymers and martingales* (Paris)
- Dr. A. Patrick *The spherical model of a ferromagnet: magnetization profile, surface tension and related properties* (Marseille)
- Dr. P. Ruelle *Sandpile models : an introduction to self-organised criticality* (Series of 10 lectures, Leuven)
- Dr. I. Tsutsui *On the Lagrangian realizations of the WZNW reductions* (ETH-Hönggerberg)
- Dr. G. da Costa *Lattice models and BW type relations* (Cambridge) Dr. B. Goldsmith *Quasi-permutation groups* (Bangor) *The role of modelling in undergraduate mathematics* (Bangor)
- Dr. P. McGill *Brownian motion, excursions, matrix factors* (Swansea, Luminy)
- Dr. P. Lynch *Diabatic initialization using a recursive digital filter* (E.C.M.W.F., Reading)
- Dr. D. McManus *Introduction to cosmic strings* (Dalhousie University) *Planar domain walls* (Dalhousie University) *The Hamiltonian formulation of general relativity and quantum cosmology* (Dalhousie University) *Weak-field gravity of circular cosmic strings* (Moncton)
- Dr. D.J. O'Connor *A renormalization group approach to finite size scaling* (Berlin) *A geometrical approach to the renormalization group* (Utrecht) *The renormalization group and finite size scaling* (Amsterdam)
- Dr. C. Nash *Ray-Singer torsion on 3 manifolds and the Riemann Zeta function* (Cambridge)
- Dr. D.H. Tchrakian *Localised Yang Mills Higgs instantons in 4 dimensions* (Ecole Polytechnique,France, Beijing) *Yang Mills Higgs model in 4 dimensions with both instantons and sphaleron solutions* (Los Alamos, Princeton) *Extended objects in all dimensions* (Massachusetts Inst. Tech.) *Overdetermination of generalised self duality* (Yerevan) *Yang Mills hierarchy* (Tianjin)
- Dr. A.I. Solomon *Microscopic theories of superconductivity* (Edinburgh) *q-Analysis* (Open University) *Which q-analogue of the squeezed oscillator* (Maryland) *Visual metaphors - mathematics and the media* (Open University) *Quantum optics*

(Shanghai) *Superconductivity - from BCS to the Hubbard model* (Shanghai) *Quantum optics* (Beijing) *Quantum groups in quantum optics* (Tianjin, China) *Group theory and symmetry in physics* (Taejon, Korea) *Group theory in superconductivity* (Taejon, Korea) *Quantum optics and quantum groups* (Seoul) *Some q-analogues of quantum optics states* (Salamanca) *Quantum groups analogues of squeezed states* (Bregenz)

6 Activities of Staff and Associates

6.1 Activities within Ireland

PROFESSOR J.T. LEWIS: Irish Mathematical Society September Meeting, 3-4 September.

PROF. J. SLEVIN: Irish Materials Forum Conference-IMF8, 14-16 September.

DR. J. BURNS: Groups in Galway Conference, 16 May.

6.2 Activities outside Ireland

PROF. J.T. LEWIS: Table Ronde, St. Cheron, 2-4 January; Third European Symposium on Analysis and Probability, Paris, 4-10 January; London Mathematical Society Conference on Mathematical Physics, Swansea, 4-6 March; Seminar, Statistical Laboratory, Cambridge, 26 May; Workshop: Brownian Motion and Large Deviations, 27 May - 4 June; Seminar, King's College, London, 4 June; Mathematisches Forschungsinstitut, Oberwolfach "Stochastic Analysis", 25-31 October; Seminar, University College Swansea, 20 November; Mathematisches Forschungsinstitut, Oberwolfach "Large Deviations", 29 November - 5 December.

PROF. L. O'RAIFEARTAIGH: University of Nijmegem, 11-14 April; Colloquium in honour of Louis Michel, Ecole Superieure de Lyon, 9-14 June; XIX International Colloquium on Group Theoretical Methods in Physics, University of Salamanca, 29 June - 3 July; University of Kingston, Ontario and NSER (Canada) Summer Institute in Theoretical Physics Workshop on Quantum Groups and Integrable Systems, 13-17 July; IVth International Colloquium on Symmetries in Science, Bregenz, Austria, 2-11 August; University of Durham, 24-29 August; Workshop on Low-Dimensional Topology and Quantum Field Theory, Cambridge, 8-10 December.

PROF. J.R. MCCONNELL: Institute of radio engineering and electronics of the Russian Academy of Sciences, Fryazion, 14-31 May; Institute of Mathematics of the Ukranian Academy of Sciences, Kiev, 1-14 June; Plenary session of the Pontifical Academy of Sciences, Rome, 26-31 October.

DR. E. BUFFET: Statistical Mechanics Meeting, Paris, 30 January, Heriot-Watt University, Edinburgh, 9 October;

DR. A. PATRICK: Université de Provence, Marseille, 1-31 July.

DR. P. RUELLE: Catholic University of Leuven, 25 May - 5 June.

DR. I. TSUTSUI: Inst. für Theoretische Physik, ETH-Hönggerberg, 1-14 June.

DR. D.J. O'CONNOR: Institute for Theoretical Physics, Utrecht, May, August and November; Journés Relativiste, Amsterdam, May; Statistical Physics 18, Moscow, August; University of Amsterdam, November.

DR. D. MCMULLAN: University of Mainz, July.

DR. D. MCMANUS: Dalhousie University, Halifax, August - December; Third Atlantic mini-conference on general relativity, Université de Moncton, 7 November.

DR. G. DA COSTA: Workshop on low dimensional topology and quantum field theory, Isaac Newton Institute for Mathematical Sciences, Cambridge, September.

DR. B. GOLDSMITH: University of North Wales, Bangor, October.

DR. B. DOLAN: GR13, Cordova, Argentina, June.

DR. P. MCGILL: Seminar on stochastic processes, Seattle, Washington, 26-28 March; Seminaire de probabilités, Luminy, Marseille, 20-26 September; INRIA, Paris, 28-29 September; Warwick, 30 September - 4 October; Swansea, 4-7 October.

DR. M. GOLDEN: Department of Mathematics and Statistics, Simon Fraser University, Canada, July - August.

DR. P. LYNCH: WMO Commission for atmospheric sciences, 13-17 January; HIRLAM 2, DMI, Copenhagen, 30 March - 2 April; HIRLAM 3, DMI, Copenhagen, 1-31 July, 27 October, Oslo, 29-30 October; ECMWF Scientific Advisory Meeting, Reading, 28-30 September; 14th EWGLAM meeting, 5-9 October, Brussels.

DR. C. NASH: Conference on Low Dimensional Topology and Quantum Field Theory, Cambridge, 7-14 September; Isaac Newton Institute for Mathematical Sciences, Cambridge, September.

DR. D.H. TCHRAKIAN: FB Physik, Kaiserslautern, 1 Jan.- 31 March; Los Alamos, February; Massachusetts Inst. Tech., February; Princeton University, February; Durham, June; Ecole Polytechnique, France, 1 June-30 September; Academia Sinica, Beijing, July; XII DGM, Tianjin, China, July; Yerevan, Armenia, September.

DR. A.I. SOLOMON: Conference on SC, Edinburgh, 30-31 January; US Army Research, North Carolina, 21-23 March; International Group Theory Committee, Duke University, North Carolina, 24 March; Conference, University of Maryland, 25-28 March; Fudan University, Shanghai, 25-31 May; Institute of Theoretical Physics, Academy of Science, Beijing, 31 May - 4 June; Nankai Institute of Mathematics, 5-9 June; KAIST, Taejon, Korea, 10-12 June; Seoul University, Korea, 13-14 June; Univ. Libre, Bruxelles, Belgium, 21-23 June; Salamanca, Spain, 29 June - 4 July; Bregenz, Austria, 2-9 August; City College, New York, 1-8 September, 8-14 October.

7 Symposia

Two Mathematical Symposia were held during the year, 15-16 April and 21-22 December. The attendance (39 in April, 44 in December) included professors, lecturers, and graduate students from the Irish universities and other third-level and research institutes, and from institutes abroad, and members of the scientific schools of DIAS.

Lectures were given as follows:

April

Review Lecture:

- Dr. E. Buffet (DCU)*Martingales and their applications*

Invited Lecture:

- Prof. D. Knuth (Stanford)*Birth of the giant component*

Lectures:

- Prof. A. O'Farrell (Maynooth)*Tangent stars : a new geometric tool*
- Dr. P. Ruelle (DIAS)*Sand piles*
- Prof. A. Wood (DCU)*Exponential asymptotics for differential and difference equations*
- Prof. J. Flavin (UCG)*A new identity and some related inequalities*

Short Talks:

- Dr. P. Dolan (Imperial College, London)*Do electromagnetic analogies hold for gravitational radiation?*
- Dr. D. McManus (DIAS)*Cosmic strings come full circle: a toroidal cosmic string solution in the weak field limit*
- Dr. M. Tuite (UCG)*Some new Monster group properties found from string theory*
- Dr. G. da Costa (DIAS)*A realization and extension of Birman-Wenzel-algebra from duality algebras in statistical mechanics*
- Mr. C. Boyd (UCD)*Pre-duals of spaces of holomorphic functions*
- Dr. J. O'Shea (UCD)*A defect relation for slowly moving target hypersurfaces*

December

Review Lectures:

- Mr. S. Hughes (Harvard)*The knotty problem of cosmic strings*
- Prof. A. Solomon (Open Univ.)*A review of q-analysis : from Gauss to q-groups*

Lectures:

- Dr. N. O'Connell (Berkeley)*On the age of our most recent common ancestor*
- Dr. T.C. Dorlas (Swansea)*Introduction to the algebraic Bethe Ansatz*
- Dr. M. Tuite (UCG)*Monstrous moonshine and uniqueness of the moonshine module*

- Dr. S. Buckley (Ann Arbor)*Reverse holder spaces*

Short Talks:

- Dr. M. Vandyck (UCC, Cork RTC)*Motion of the sources in general relativity with application from cosmic strings*
- Prof. P. Quinlan (UCC)*Large-scale systems of edge-functions for microelectronics*
- Dr. P. Lynch (Met. Service)*Digital filtering and the vindication of Lewis Fry Richardson*
- Dr. P. Crehan (UCD)*The geometry of degenerate Poisson manifolds*
- Dr. N. Duffield (DCU)*Upper bounds for queue lengths in multiplexers*
- Prof. N. O Murchadha (UCC)*Spherical cosmologies : a counterexample to Mach's principle*

8 Visitors

As in previous years, visitors from abroad came to the School for short or long periods, for discussions with School's members, to give seminars, and to avail of the School's library resources for their research work. For lectures given by visitors see section 5.2

Short visits (up to one week):
V.I. Arnold (Moscow) 28 Oct.,
V. Blagodatskikh (Moscow) 30 July,
D. Botvich (Moscow) 15-22 May,
S. Buckley (Ann Arbor) 21-23 Dec.,
R. Coquereaux (Marseille) 28 Oct. - 3 Nov.,
A.I.S. Corner (Oxford) 27-31 Mar.,
E. Corrigan (Durham) 8-11 Feb.,
T. Dorlas (Swansea) 1-4 Nov., 21-23 Dec.,
S. Gupta (Syracuse) 25 May,
S. Hughes (Harvard) 21-23 Dec.,
G. Jorjadze (Tbilisi) 6-11 Nov.,
D. Knuth (Stanford) 16 April,
P.McGill (Irvine) 11-15 May,
E.F. Mishchenko (Moscow) 30 July,
M. Muldoon (Warwick) 23-30 Mar.,
J. Noble (Cork) 20-21 Oct., 16-18 Nov.,
N. O'Connell (Berkeley) 21-23 Dec.,
A.I. Solomon (Open University) 21-23 Dec.,
C. Stephens (Utrecht) 13-20 Feb.,
N. Straumann (Zurich) 23-30 Sept.,
M.P. Tuite (Galway) 21-23 Dec.,
A. Verbeure (Leuven) 10-14 June, 24-27 Nov,

Longer visits:
H. Asatryan (Armenia) 27 Nov. - 10 Dec.,
M. van den Berg (Edinburgh) 22 July - 1 August,
W. Cegla (Wroclaw) 29 July - 7 August,
L. Fehér (Montreal) 10-27 Oct.,
G.W. Ford (Michigan) 14-28 June, 13 July - 1 Aug.,
V.I. Gaiduk (Moscow) 7 Nov. - 5 Dec.,
R. Göbel (Essen) 7-22 Mar.,
D. Karakhanian (Armenia) 27 Nov. - 11 Dec.,
M. Kelbert (Moscow) 11-31 May, 22 Nov. - 20 Dec.,
M. Lavelle (Regensburg) 15-23 Jan.,
M. Lavelle (Mainz) 11-25 Oct.,
W. McGlinn (Notre Dame) 23 May -7 June,
R.F. O'Connell (Louisiana) 5 June - 17 August,
C. Pfister (Lausanne) 7-17 Oct.,
V.B. Priezzhev (Dubna) 2 May - 20 June,
M. Saveliev (Lyon) 15 Sept. - 14 Oct.,
R. Sorkin (Syracuse) 27 May - 11 June,
I. Soukhov (Cambridge) 6-30 Aug., 1-20 Dec.,
C. Stephens (Utrecht) 15-24 July,
P.J. Upton (Oxford) 31 Aug. - 11 Sept.,
N. Vvedenskaia (Moscow) 23 Aug. - 14 Sept.,
A. Wipf (Zurich) 22 Sept. - 9 Oct.

9 Publications

Note: Items marked with an asterisk have been recorded as in press in previous reports.

9.1 Books

C. Nash: Differential topology and quantum field theory. *New paperback edition, Academic Press, 1992*

9.2 Communications of the Dublin Institute for Advanced Studies, Series A (Theoretical Physics)

None published.

9.3 Contributions to periodical and other publications

*L. O'Raifeartaigh: Conformal reduction and W-algebras. *Proc. of Workshop on Selected Topics in Modern Math. Phys., Borjomi, Georgia, 1991, World Scientific.*

*L. O'Raifeartaigh, P. Ruelle, I. Tsutsui, & A. Wipf: W-Algebras for generalized Toda theories. *Commun. Math. Phys.* **143**(1992)333-354.

*L. Fehér, L. O'Raifeartaigh, P. Ruelle, I. Tsutsui, & A. Wipf: Generalised Toda theories and W-algebras associated with integral gradings. *Ann. Phys.* **213**(1992)1-20.

*L. Fehér, L. O'Raifeartaigh, P. Ruelle, & I. Tsutsui: Polynomial and primary field character of W_n^l-algebras. *Phys. Lett. B* **283**(1992)243.

*L. Fehér, L. O'Raifeartaigh, P. Ruelle, I. Tsutsui, & A. Wipf: On the general structure of Hamiltonian reductions of the WZNW theory. *Phys. Rep.* **222**(1992)1.

*L. O'Raifeartaigh: Constrained WZNW theories and integrable systems. *Proc. Sudarshan Workshop, Austin, Texas, 1991, World Scientific.*

*A. Balachandran, W. McGlinn, L. O'Raifeartaigh, S. Sen, & R. Sorkin: The spin-statistics connection from homology groups of configuration space and an Anyon Wess-Zumino term. *Inter. J. Mod. Phys. A* **7**(1992)6887.

*A. Balachandran, W. McGlinn, L. O'Raifeartaigh, S. Sen, & R. Sorkin: Topological spin-statistics theorem for strings. *Mod. Phys. Lett. A* **7**(1992)1427.

*M. McGettrick, W. McGlinn, N. Gorman, & L. O'Raifeartaigh: Virasoro operators for arbitrarily twisted Kac-Moody algebras. *Int. J. Mod. Phys.* **7**(1992)2547-2558.

*J.R. McConnell: Dielettrici in campi elettrici variabili. *Enciclopedia delle Scienze Fisiche, Accademia Nazionale dei Lincei, Roma, 1992.*

J. McConnell: Molecular coordinate systems for relaxation processes. *Jn. Molecular Liquids* **52**(1992)81-95.

P. Ruelle, & S. Sen: Toppling distributions in one-dimensional abelian sandpiles. *J. Phys. A* **25**(1992)L1257.

*A. Patrick: Random infinite-volume Gibbs states for the Curie-Weiss random field Ising model. *J. Stat. Phys.* **66**(1992)139-164.

*A. Patrick: Parallel dynamics for an extremely diluted neural network (comment). *J. Phys. A* **25**(1992)1009-1011.

G.M. O'Brien, & D.H. Tchrakian: A non-abelian Higgs model with instantons and sphaleron. *Physics Letters B* **282**(1992) 111.

*H.J.W. Müller-Kirsten, & D.H. Tchrakian: A class of (2+1)-dimensional models with instanton and sphaleron-like solutions. *J. Phys.A.* **25**(1992)L321.

*H.J.W. Müller-Kirsten, J.-Q. Liang, & D.H. Tchrakian: Solitons, vortices and sphalerons on a circle. *Phys. Lett. B* **282**(1992)105.

A. Chakrabarti, B. Piette, D.H. Tchrakian, & A. Zakrzewski: A class of N dimensional models with extended structure solutions. *Zeit. fur Physik C* **56**(1992)461.

*B. Piette, D.H. Tchrakian, & W.J. Zakrzowski: A class of (2+1)-dimensional models with extended structure solutions. *Zeit. Physik C* **54**(1992)497.

Z.-Q. Ma, & D.H. Tchrakian: Wu-Yang fields. *Lett. Math. Phys.* **26**(1992)179.

T.N. Sherry, & D.H. Tchrakian: Can the electroweak model be extended to support instanton solutions. *Phys. Lett. B* **295**(1992)237.

O.F. Dayi, H.J.W. Müller-Kirsten, A.G. Shurgaia, & D.H. Tchrakian: Model of a superconducting cosmic string. *Phys. Lett. B* **286**(1992)234.

H.J.W. Müller-Kirsten, & D.H. Tchrakian: A (2+1)-dimensional model with instanton and sphaleron solutions. *Mod. Phys. Lett. A* **7**(1992)3801.

*M. Lavelle, & D. McMullan: Problems with the path integral description of the temporal, light-cone and Fock-Schwinger gauges. *Mod. Phys. Lett. A.* **7**(1992)219-224.

D. O'Connor, & C.R. Stephens: Critical phenomena during a dimensional crossover. *J. Phys. A* **25**(1992)101-108.

D. O'Connor, & C.R. Stephens: Superconductivity in an external magnetic field as a finite size system. *Phys. Rev. B* **43**(1991)3652-3655.

D. O'Connor, & C.R. Stephens: A renormalization group approach to finite size scaling. *Abstracts of Stat. Phys.* **18**(1992)307.

D. O'Connor, & C.R. Stephens: Scaling behaviour and effective exponents for finite size systems. *Abstracts of Stat. Phys.* **18**(1992)166.

D. O'Connor, & C.R. Stephens: A new scaling formulation for finite size ferromagnets. *J. Magnetism and Magnetic Materials* **104-107**(1992)300-302.

D. O'Connor, & C.R. Stephens: A new approach to the critical behaviour of systems exhibiting a dimensional crossover. *J. Magnetism and Magnetic Materials* **104-107**(1992)294-296.

Y. Kubyshin, & D. O'Connor: Decoupling of heavy fermions in the Kaluza-Klein approach. *Proceedings of Quarks '92, Zvenigevod, Russia*

D.J. McManus: Generalised splitting of space-time. *General Relativity and Gravitation* **24**(1992)659.

*M. Lavelle, & D. McMullan: Gauge fixing, unitarity and phase space path integrals. *Int. J. Mod. Phys.* **7**(1992)5245-5279.

*D. McMullan: Classical states and the BRST charge. *Commun. Math. Phys.* **149**(1992)161-174.

*M. Lavelle, & D. McMullan: Problems with the path integral description of the temporal, light-cone and Fock-Schwinger gauges. *Mod. Phys. Lett. A.* **7**(1992)219-224.

D.G.C. McKeon, & T.N. Sherry: Operator regularization and the phase of one-loop determinants. *Annals of Physics* **218**(1992)325-345.

*B.P. Dolan, & C. Nash: Zeta function continuation and the Casimir energy on odd and even dimensional spheres. *Comm. Math. Phys.* **148**(1992)139-153.

*P. McGill: Generalised transforms, quasi diffusions, and Désiré Andrés' equation. *Seminaire de Prob. XXVI. Springer Lecture notes in Mathematics No. 1526(1992)234-247.*

*P. McGill: Borel-Cantelli lemmas in continuous time. *Stochastic and Quantum Mechanics, eds. A. Truman and I.M. Davies, World Scientific Press (1992)205-211.*

*P. McGill: On the structure of a transition kernel. *Stochastic and Quantum Mechanics, eds. A. Truman and I.M. Davies, World Scientific Press (1992)212-217.*

*R. Göbel, & B. Goldsmith: On almost free modules over complete discrete valuation domains. *Rend. Sem. Mat. Univ. di Padova* **86**(1991)75-87.

*A.G. O'Farrell, & R.O. Watson: The tangent stars of a set, and extensions of smooth functions. *J. für die Reine und Angew. Math.* **430**(1992)109-137.

*A.G. O'Farrell, & F. Perez-Gonzalez: Pointwise bounded approximation by polynomials. *Math. Proc. Camb. Phil. Soc.* **112**(1992)147-155.

*A.G. O'Farrell: "T-invariance". *Proc. R.I.A.* **92A**(1992)185-203.

*P. Lynch, & H. Xiang-Yu: Initialization of the HIRLAM model using a digital filter. *Mon. Weather Rev.* **120**(1992)1019-1034.

*P. Lynch: Richardson's barotropic forecast - a reappraisal. *Bull. Amer. Met. Soc.* **73**(1992)35-47.

P. Lynch: Data needs and assimilation for weather prediction. *Report of CAS group of rapporteurs on short-range weather prediction research, Bracknell, U.K. 1992. PWPR No. 1, WMO/TD No. 479 WMO, Geneva.*

P. Lynch: Digital filters for numerical weather prediction. *HIRLAM Technical Report No. 10, 1992, 52pp.*

J. Burzlaff: A barrier penetration formula for optical tunnelling models. *Proceedings of the Sixth European Conference on Mathematics in Industry, ed. F. Hodnett. Stuttgart: Teubner 1992. p.91*

J. Burzlaff, A. Chakrabarti, & D.H. Tchrakian: Generalised self-dual Chern-Simons vortices. *Phys. Lett. B* **293**(1992)127.

M.J. Conneely, L. Lipsky, & A. Russek: Three-electron systems with inner-shell vacancies. *Phys. Rev. A* **46**(1992)4012-4025.

B.K.P. Scaife: On the effect of finite crossing-time on the frequency-dependent polarizability of a dipole with two, anti-parallel, equilibrium positions separated by a high energy barrier. *J. Molecular Liquids* **49**(1991)163-8.

C. Nash: A comment on Witten's topological Lagrangian. *Modern Phys. Lett. A* **7**(1992)1953-1958.

A.I. Solomon: Which q-analogue of the squeezed oscillator. *Proceedings of the Harmonic Oscillator Conference, Maryland. Nova, 1992.*

A.I. Solomon: Quantum groups in quantum optics. *Proceedings of the Differential Geometry Conference, Tianjin, China. World Scientific, 1992.*

A.I. Solomon: Some q-analogues of quantum optics states. *Proceedings of the Group Theoretical Methods Conference, Salamanca. World Scientific, 1992.*

A.I. Solomon: Quantum group analogues of squeezed states. *Proceedings, Symmetries in Science VI. Plenum, 1992.*

J.M. Burns: Homotopy of compact symmetric spaces. *Glasgow Math. J.* **34**(1992)221-228.

B. Jensen, J.G.McLaughlin, & A. Ottewill: Anisotropy of the quantum thermal state in Schwarzschild space-time. *Phys. Rev. D* **45**(1992)3002.

B. Allen, J.G.McLaughlin, & A. Ottewill: Photon and graviton Green's functions on cosmic string space-times. *Phys. Rev. D* **45**(1992)4486.

B. Allen, J.G.McLaughlin, & A. Ottewill: Examples of the Vilkovisky-DeWitt effective action in one-loop quantum gravity. *Phys. Rev. D* **45**(1992)4504.

B. Allen, & A. Ottewill: Gauge dependence in Hadamard renormalization. *Phys. Rev. D* **46**(1992)861.

L.H. Ford, P.G. Grove, & A. Ottewill: Macroscopic detection of negative energy fluxes. *Phys. Rev. D* **46**(1992)4566.

10 Library

Approximately 210 new titles were added to the library stock during the year; 200 current periodicals were taken, of which almost half were received by gift or under exchange arrangements. Due to lack of space we were unable to continue participation in the RIA permanent loan scheme. Other libraries in Dublin agreed to accept the journals and the collection was sorted and delivered to their new locations. Work on the reorganisation of the library and the stores was completed during the summer. As in previous years, offprints and preprints were received from many scientific institutes and university departments at home and abroad, either directly or in response to requests.

Annual report of the Governing Board of the School of Cosmic Physics for the year ending 31 December 1992 adopted at its meeting on 17 June 1993.

1 Staff, Scholars and Associates

SENIOR PROFESSORS: L. O'C. Drury (Director), A. W. B. Jacob, P. A. Wayman (to 31 October)

PROFESSORS: T. Kiang, A. Thompson (one vacancy)

ASSISTANT PROFESSORS: D. O'Sullivan, T. P. Ray

RESEARCH ASSISTANTS: I. Elliott, P. W. Readman, (one vacancy)

EXPERIMENTAL OFFICERS: T. A. Blake, B. D. Jordan, W.-M. Tai

VISITING SCIENTISTS: C. Brown (Galway), M. Burton (Anglo Australian Observatory), C. Domingo (UAB, Barcelona), J. Eislöffel (MPIA), M. Ford (Zurich), F. Jansen (ESTEC), J. Luetgert (Menlo Park, California), J. Makris (Hamburg), R. Mundt (MPIA, Germany), C. Prodehl (Karlsruhe) A. Raga (U Manchester), K. Stammler (Erlangen), I. G. van Breda (Cambridge, England), W. Vogt (Hamburg), K.-P. Wenzel (ESTEC)

TECHNICAL AND CLERICAL STAFF: K. Bolster, G. Broderick, A. Byrne, A. M. Callanan, E. Clifton, W. Dumpleton, E. Flood, A. Grace-Casey, C. M. Horan, S. Ledwidge, M. Smyth, H. Sullivan, G. Wallace, (two vacancies)

SCHOLARS: J. Bosch, M. Callinan (to 30 June) D. Corcoran, M. Corcoran, K. Farrell (from 1 October), R. Keegan, I. O'Brien, S. P. Xiang

PROJECT SUPPORTED POSITIONS: J. Byrne (IRMA, from 1 Oct), F. Hauser (RAPIDS), A. Moorhouse (Low Mass Star Formation), B. O'Reilly (RAPIDS, from 1 September), S. Russell (ISOPHOT)

PROFESSORS EMERITI: H. A. Brück, C. O'Ceallaigh, T. Murphy, P. A. Wayman (from 1 November)

RESEARCH ASSOCIATES: C. J. Bean (UCD), P. B. Byrne (Armagh), M. Cawley (SPCM), M. Hoey (UCD), R. Keary (GSI), E. Kennedy (DCU), J. Makris (Hamburg), N. P. Murphy (BP), W. E. A. Phillips (TCD), C. Prodehl (Karlsruhe), R. M. Redfern (UCG), P. M. Shannon (UCD)

VACATION STUDENTS: G. Byrne (UCD), M. Davey (TCD), S. Dolan (UCD), D. Foster (TCD), M. Heanue (SPCM), P. Hicks (UCD), D. Jordan (UCD)

2 Research Activities in the Cosmic Ray Section

2.1 Gamma-ray production in SNRs

L Drury with MPIK

It is thought that the bulk of the Galactic cosmic rays (in particular those with rigidities below about 10^{14} V) are produced in supernova remnants (SNRs) by diffusive shock acceleration, but there is no direct evidence for this. The main reason for the general belief in this concept is, first, that an elegant theory can be constructed which appears to be reasonably successful in describing many characteristics of the cosmic rays and secondly, that no plausible rival source has been proposed. However this is clearly an unsatisfactory situation.

The best hope of observationally testing the idea that the cosmic rays are mainly produced in SNRs, as has long been realised, is by means of gamma-ray astronomy. If SNRs contain freshly accelerated cosmic rays, these will interact with the swept up interstellar matter and supernova ejecta to produce π^0 decay gamma-rays. This idea (in the general context of point sources of cosmic rays) is at least 20 years old. Two factors make a detailed reanalysis worthwhile. First, there have recently been significant technical advances in gamma-ray astronomy. Secondly the models for particle acceleration in SNRs are now quite specific and detailed (for example the simplified models developed over the last few years in an ongoing collaboration with the MPIK in Heidelberg).

On the basis of the simplified dynamical models the expected gamma-ray luminosity of SNRs due to hadronic interactions has been evaluated (note that there will also be gamma-ray production in SNRs by various electromagnetic processes; by considering only production by the decay of secondary π^0 particles we obtain a lower

bound on the luminosity) and compared with the current sensitivities of various detectors and the expected Galactic backgrounds. The result is that detection of SNRs in the 100 MeV band accessible to space experiments such as EGRET on NASA's Compton Gamma Ray Observatory will be very difficult, but may be possible. However if the theory is correct detection in the TeV region accessible to imaging atmospheric cherenkov telescopes should be much easier. Over the next few years such observations may allow a decisive test of our theoretical ideas.

2.2 Secular evolution of shock structures modified by particle acceleration

K Farrell and L Drury with DCU

There remain many aspects of the nonlinear evolution of shock structures modified by particle acceleration which have not been properly explored numerically. The problem is that with conventional methods the amount of computational work involved grows exponentially as the shock structure evolves. Thus most work has been confined to the early phases of acceleration and has only covered a small dynamic range in particle energy.

It is proposed to develop an efficient code to study these secular effects by combining three techniques; an adaptive grid, a semi-implicit solution of the hydrodynamic equations, and operator splitting to combine the spectral evolution with the hydrodynamics.

2.3 Nonthermal effects in C-shocks

I O'Brien, L Drury and A Moorehouse

The high temperatures predicted by current models of shocks in molecular clouds are incompatible with observation. Difficulties are encountered in explaining the low observed levels of molecular dissociation and the chemical composition of the post-shock media. Magnetohydrodynamic (MHD) models go some way towards solving the problems. These models treat the various components of the gas as separate gases, coupled by energy and momentum transfer. Due to compression of the magnetic field across the shock front, ionised particles stream through neutral particles in advance of the shock front, transferring energy gradually. This leads to magnetic precursors to shocks or continuous shocks, where the shock is spatially extended. This increases the time over which the gases are heated and allows significant radiation, thereby reducing the peak temperature.

The success of MHD models is limited and more work is clearly needed to explain observations. One critical assumption of MHD models is that the molecules are in thermodynamic equilibrium at all times and, therefore, that the temperature of the neutral gas rises slowly. The large collision lengths in the system, however, challenge this assumption as an internally excited particle will have a significant chance to radiate between collisions. Thus in the time between an initial ion-neutral collision and the establishment of a roughly thermal distribution of the energy thus transferred to the bulk of neutral molecules, much of it may be radiated, increasing the cooling of the system significantly.

Considering a system of discrete particles, rather than using a continuous model, and carrying out Monte Carlo simulations, it should be possible to quantify this effect, which is expected to be significant. A Monte Carlo simulation program is being written, considering the cold pre-shock gas as composed solely of molecular hydrogen. This model will be used to consider the heating of molecules throughout an entire shock, as well as profiling the radiation expected from such a shock.

2.4 The Infrared Space Observatory

S. Russell

The ground based preparatory programme for the Infrared Space Observatory (ISO) has gone ahead with great vigour during the year, after a meeting in Stockholm to coordinate research efforts. Several mm-continuum surveys with the Swedish-ESO Submillimetre Telescope (SEST) and the James Clarke Maxwell Telescope (JCMT), have been carried out on targets intended for observation with ISO. Encouragingly, many of these targets were detected. Future research will be based around prior observations at molecular line frequencies (CS and $C^{18}O$), with follow ups in the mm-continuum at the density peaks.

S. Russell continued as chairman of the Infrared Space Observatory (ISO) working group coordinating guaranteed time core proposals on star formation. He was also a member of the ISO working groups on the Ground Based Preparatory Programme (GBPP), in charge of coordi-

nating millimetre continuum observations of star formation regions; on coordinating guaranteed time core proposals on supernova remnants; on coordinating guaranteed time core proposals on extragalactic sources; and on coordinating Astronomical Observing Templates (AOTs).

2.5 Lithium abundance Problems

S. Russell

A week was granted at the begining of the year to observe δ Scuti stars with the Jacobus Kapteyn Telescope (JKT) in La Palma. These stars are thought to be candidates for explaining the lithium dip in evolved F5 dwarfs. Hopefully with these data we will be able to say whether or not δ Scuti stars can possibly be responsible.

In January of this year, three nights were obtained on the William Herschel Telescope (WHT) in La Palma to observe lithium in clusters of various young ages. With this it is hoped to determine whether the excessive scatter in abundances seen in clusters younger than the Hyades can simply be explained as a result of modelling-errors in the resonance line of lithium.

2.6 Star Formation

T. Ray, D. Corcoran, M. Corcoran and A. Moorhouse

As in previous years, most of the star formation group's effort has centered on understanding mass loss from young stellar objects (YSOs). Such mass loss manifests itself in a number of ways, for example by the occurrence of P Cygni profiles in the spectra of young stars and by the presence of extended, large scale, atomic and molecular outflows. The outflow component with the highest degree of collimation, and the highest velocities, is, however, seen optically in the form of Herbig–Haro (HH) objects and HH-like jets. These jets are highly supersonic, with Mach numbers of around 20–30, and extend for several light years from their source. Paradoxically at the same time these stars are losing mass through outflows, they are accreting it from their environment. This they do through an "accretion disk" surrounding the young star and it is these disks which are thought to eventually evolve into planetary systems. Optical outflows, the shocks they drive into their surroundings, and disks have figured prominently in the work of the group and studying them has involved the use of a large number of first class astronomical facilities during the year including the Caltech Sub-millimeter Observatory, the Canadian French Hawaiian Telescope (CFHT), the United Kingdom Infrared Telescope (UKIRT) and the 2.2m Max Planck Society Telescope in Chile.

Much of the earlier efforts of the group concentrated on outflows from low mass stars although it is now found that this phenomenon is also common amongst their higher mass counterparts. Particular attention has been focussed on Herbig Ae/Be stars (stars typically of 100-10000 solar luminosities). M. Corcoran and T. Ray using data taken at the Isaac Newton Telescope and Chile have found that optical outflows occur only if these stars have a large infrared excess. As this excess is indicative of the presence of a disk, this shows clearly the link between disks and outflows. Moreover in those cases where an optical outflow is present, as indicated by forbidden line emission, only blueshifted high velocity emission is seen. The most natural explanation of this asymmetry is that their redshifted emission is obscured by a disk.

D. Corcoran has examined in detail several optical outflows from high luminosity young stars including LkHα 198, V380 Ori and Cepheus A. It seems from studying these and other optical outflows from intermediate mass stars that the outflows are much more poorly collimated in general than those originating from lower mass stars. In particular V380 Ori, like Cep A, produces a ring of HH emission.

In collaboration with Anneila Sargent (Caltech) and Steve Beckwith (MPIA), they have looked into the question of how much dust surrounds post T Tauri stars (PTTSs). A typical classical T Tauri star (CTTS) is about 1-10 million years old, whereas it takes about 100 – 300 million years after its formation for a solar mass star to settle down on the Main Sequence. This gap between CTTSs and the Main Sequence on the HR diagram is filled by the PTTSs. CTTSs show unequivocal evidence for disks as evidenced by their mm emission and they wanted to see how such disks evolve with time. Surprisingly no evidence was found for mm emission amongst the PTTSs surveyed even though some of these stars were five times nearer than the nearest star forming regions. At the same time Ray has discovered from data taken with the Infrared Astronomical Satellite (IRAS) that PTTSs do have an infrared

excess. This excess is above that expected from a simple blackbody in the infrared, particularly at long wavelengths. The form of the PTTS spectral energy distribution suggests that the inner portion of the disk evolves first perhaps as a result of the initial phases of planetary formation.

A. Moorhouse has presented new near-infrared spectroscopic data on the well-known outflow HH 7-11 consistent with models of non-magnetic J-type (jump) or magnetically dominated C-type (continuous) shocks, but precluding precursors. Outflows in regions of normal and high magnetic field strength were examined with Mike Smith (Trieste) and Peter Brand (Edinburgh), leading Moorhouse to propose that the surroundings of outflows have magnetic field strengths orders of magnitude larger than expected. Moorhouse also considered the effects of UV-radiation on the environment near YSOs, this work led directly to the first ever detection of molecular hydrogen lines in the near-infrared.

2.7 The Ultra Heavy Cosmic Ray Experiment (UHCRE) on the LDEF Mission

D. O'Sullivan, A. Thompson, J. Bosch and R. Keegan with K.-P. Wenzel and F. Jansen (ESTEC) and C. Domingo (UAB)

Data acquisition, measurements and preliminary data analysis continued during the year. Event location proceeded very satisfactorily and earlier estimates which indicated a total sample of $\sim$ 3000 ultra heavy cosmic ray candidates with charge greater than 65 were confirmed. Approximately seventy five per cent of the detector stacks had been scanned by the end of the year. Processing of the detectors continued at a steady rate.

Measurements on the ultra heavy candidates continued and it was recognised that because of the very large sample involved (approximately ten times the total pre LDEF world sample), a special effort would have to be made to complete data acquisition within a reasonable length of time. By the end of the year successful routines had been established to ensure a satisfactory rate of progress. Earlier, discussions with Professor Biswas of the Tata Institute resulted in an agreement to include his group in the project.

An opportunity to calibrate some UHCRE detectors with very high energy (10.6 GeV/N) gold nuclei was taken in April when the Siegen University group offered to include the DIAS material in an exposure they had scheduled at Brookhaven. Earlier calibrations had been carried out with nuclei of lower energy ($\sim$ 1GeV/N), the most energetic available at the time. Since the UHCRE data comprises data almost entirely in the energy region above 2GeV/N the latest exposure at Brookhaven will be of importance in determining the detector response at these higher energies.

Analysis of the first sample of approximately one hundred events indicated good charge resolution with charge spreads of $\sim \pm 1.0$e and the presence of a number of actinide candidates.

2.8 Ionising Radiation Measurements at Aircraft Altitudes (IRMA Project)

D. O'Sullivan and J. Byrne

Following discussions with colleagues in Rome, Munich and Siegen it was decided to seek funding from the European Community to carry out a systematic investigation of cosmic rays at altitudes up to $\sim$ 80,000 feet in the Earth's atmosphere in order to provide data for dosimetric studies on air crew and passengers. The DIAS group intended to study heavy nuclei, which although rare at these altitudes, are considered to have significant effects on human tissue and which, along with other sources of radiation such as neutrons and protons, have become of interest to all concerned. Eventually a proposal was submitted by a team including scientists from ENEA (Rome), GSF (Munich), the Universities of Siegen and Saarland, and DIAS. Prof. Ian McAulay (TCD) accepted an invitation to be co-ordinator. The proposal was successful and a two year contract was signed in October 1992.

At the first group meeting in Brussels In October it was decided to concentrate initially on those altitudes most commonly used in air travel (<40,000) and to extend the investigation to higher altitudes later if possible. While the flux of heavy nuclei expected at the higher altitudes is not insignificant, the results of the initial DIAS study will depend on the total area-time factor to be negotiated with airlines and could produce a null result for nuclei with charge greater than ten. Exposures at higher altitudes (in Concorde or suitable military aircraft) would provide statistically significant samples if reasonable area-time factors were achieved. Medium altitude balloon flights could

also be attractive. Negotiations have already begun with various authorities in the hope of arranging such exposures.

During November detector stacks were prepared for the IRMA investigation and arrangements were made, at short notice, to carry out some initial calibrations at the Berkeley Bevalac. Exposures to the final Ca and Fe beams were successful and the calibration was the last one to be carried out at Berkeley by the DIAS group (the facility closed in February 1993).

2.9 The Energetic Particle Analyser (EPA) on the Giotto Extended Mission

A. Thompson and D. O'Sullivan with S. McKenna-Lawlor (SPCM), MPAe and ESTEC

During the year the Giotto Extended Mission (GEM) was successfully completed. On 10 July the spacecraft passed within about 200 km of the nucleus of comet Grigg-Skjellerup and conducted *in situ* measurements using all operational instruments. This is only the third comet at which such measurements have been made and the encounter constituted the closest approach, so far, of a spacecraft to a cometary nucleus.

The EPA instrument, operating in real time mode, detected energetic charged particles deep within the inner coma of comet Grigg-Skjellerup. In contrast to previous encounters with comets Giacobini-Zinner (ICE in 1985) and Halley (Giotto in 1986), well defined periodic intensity variations recorded in the particle fluxes suggest that the ions close to the nucleus were strongly coupled to the ambient magnetic field. Results from the preliminary analyses of these EPA observations have been submitted to Nature.

2.10 The Solar Low Energy Detector (SLED) on the Phobos Mission

A. Thompson and D. O'Sullivan with S. McKenna-Lawlor (SPCM), MPAe, KFKI and IKI

Analysis of charged particle data obtained by the SLED instrument on Phobos-2 in orbit about Mars continued. Significant flux enhancements in the approximate range 30 to 350 keV were detected inside the magnetopause in the same general locations less than 9000 km above Mars over a period of eight days during three consecutive elliptical orbits. Possible explanations include the presence of quasi-trapped radiation at the planet Mars and the detection of the propagation of accelerated particles along the boundary of the magnetopause from the day to the night side of the planet.

During circular orbits, many major ion flux increases (over an order of magnitude) in the approximate range 30 to 200 keV were observed adjacent to the bow shock, both inbound and outbound. It was concluded that the particles concerned were O^+ ions. In the prevailing solar wind conditions, the pickup process would have been sufficient to accelerate such ions to the observed energies. Afterwards these ions might have leaked upstream from inside the magnetopause, perhaps undergoing shock-drift acceleration at the bow shock in the process. Particle flux enhancements in the magnetotail in the approximate energy range 30 to 50 keV are interpreted as the signature of O^+ ions, impelled by acceleration processes similar to those associated with terrestrial auroral ion beams.

3 Research Activities in the Astronomy Section

3.1 The Boheh Stone.

P.A. Wayman

The situation of the Boheh Stone, Co. Mayo, with respect to the apparent profile of Croagh Patrick was found by G.G. Bracken of Westport, Co. Mayo to be such that on certain dates the setting sun viewed from this inscribed stone appears to descend so as to be tangential to that profile on its North face. On finding that the markings on the Boheh Stone are not otherwise interpreted, the circumstances of this phenomenon, similar to some less striking cases discovered in the Western Isles of Scotland, were investigated in detail and the significance of the exact dates in April and August in regard to the sowing and harvesting of crops was considered briefly.

3.2 Image Sharpening Techniques

B. Jordan

A new four channel Transputer based interface for four Analog-Digital Converters for an Image Photon Detector (IPD) was designed and constructed. A four channel peak detector

for controlling the Analog-Digital converters provided by the UCG group was modified to provide optimum response to IPD signals. The complete system was integrated with the UCG data acquisition system and tested using the Maynooth IPD. Final testing of the complete Image Sharpening instrument TRIFFID using the Rutherford Appleton Laboratory (RAL) Photon Counting Detector (PCD) for image monitoring and the IPD system for narrow band photon detection was carried out at Dunsink in May. The equipment was used for two observing runs at the GHRIL (Groundbased High Resolution Imaging Laboratory) facility of the William Herschel Telescope in June and November. During these runs we used the ESO Multi Anode Microchannel Array (MAMA) detector as the primary detector and the GHRIL IPD with the new digital processing electronics as back up for the main detector. The RAL PCD was used for the side arm or image monitoring detector. The acquired data demonstrates that the new digital processing of the IPD signals yields IPD images having 10 bit spatial resolution. This compares with 7 bit resolution using the original analog signal processing electronics previously available. The original unprocessed data, an image of the core of the globular cluster M15, has resolution to 0.75 arc seconds but the post observational processed and sharpened images show detail down to 0.2 arc seconds.

3.3 Relativity and Cosmology

S.-P. Xiang and T. Kiang

The most crucial support to the standard Big Bang cosmology came from the new results on the anisotropies of the cosmic microwave background radiation (CMBR) given by the COBE satellite in April. The results of COBE not only give the lower limit of the quadrupole anisotropy of the CMBR which is necessary for the formation of the present observed cosmic structure, but also show that there is large power on large scales which is impossible to explain by the standard cold-dark-matter-only cosmological model. The hybrid dark matter model (containing both cold and hot dark matter), on which Xiang and Kiang have been working, was regarded as one of two models most likely to be successful at the Texas/PASCOS 92 Conference, held in Berkeley in December.

In their hybrid model, the cold dark matter is treated by a fluid approximation, as are the radiation and baryons, while the hot dark matter (massive neutrinos) is treated as a collisionless gas with Fermi-Dirac distribution. Their calculations favour a comparable mix of hot and cold dark matter and a Hubble constant near the middle of the generally accepted range. Detailed results have been given and published.

3.4 Solar System Dynamics

T. Kiang

The long-standing problem of Kirkwood Gaps in the distribution of the periods of asteroids cannot be said to have been solved. Some years ago, Wisdom and others indicated that the 3/1 gap could be understood in terms of chaotic dynamics, but none have claimed success using this approach with the more pronounced 2/1 gap. In any case, the alternative approach of linear stability of periodic orbits should not be forgotten, especially if one has access to very powerful computers. The Vax 760/10 of UCD can be, and has been used to establish the stability character of orbits over a time-scale of one million years; to go beyond that by two to three orders of magnitude —to the time-scale of the system of asteroids, quadruple precision arithmetic has to be used and that can only effectively be carried out by much more powerful computers such as the Cray. During a UCD 4-day study-visit to the Cray Centre at Bracknell in April, an initial attempt to get more specific results was made.

3.5 Cosmology: Some Basics

T. Kiang

The one sure observational fact in cosmology that is also a direct consequence of the cosmological principle is that, at any time, the recession speed of a distant galaxy is proportional to its distance and that this law holds exactly for *all* distances. Accordingly, there is a distance D at which the galaxy recedes with the velocity of light c. It is generally thought that D marks some sort of observable limit; but this would be a misunderstanding: in a Big Bang universe, there is nothing special about the distance D, there are galaxies there and beyond, receding with speeds equal to and greater than c, and the light from these galaxies will reach us in due time. The misconception arises from an insufficient appre-

ciation of what is meant by expanding space and the fact that expanding space is **not** the space envisaged in Einstein's special relativity. This error is made even by some professional physicists (Cf. the May issue of Mercury), and the wrong premise that we cannot observe galaxies receding faster than c was used to explain the notion of horizon. This widespread misconception was discussed in lectures on several occasions during the year and much time was spent in devising analogies that the general public would understand.

3.6 Detectors and Image Intensifiers

I. G. van Breda

The collaboration with Rutherford Appleton Laboratory (RAL) on photon counting detectors and microchannel plate (MCP) intensifiers was continued. Discussions led to the setting up of a European Network for High Resolution Imaging. A paper was produced reviewing the development of the Rutherford Appleton Laboratory Photon Counting Detector. This was presented as a poster paper at the ESA Symposium on Photon Detectors for Space Instrumentation at Noordwijk in November. The same detector was used successfully by the UCG/Dunsink/RAL collaboration for image sharpening observations on the William Herschel Telescope at La Palma and the ESO New Technology Telescope (NTT) in Chile.

3.7 CCDs

I. G. van Breda

Investigation of the possibility of some charge coupled device (CCD) development occurring at Dunsink in collaboration with RAL and SAAO was continued. The first circuit boards for the project were obtained.

3.8 Instrument Control

I. G. van Breda

Further studies on the possibility of using a parallel-processing engine for the control of astronomical telescopes and instruments were conducted. In particular, the concept of a distributed data base as a means for implementing real time control was shown to be feasible within the astronomical context. An advantage of this approach is that a large part of the control system lies in the structure of the data base, and relatively little in the actual real time coding. It also dispenses with the need for a complex real time operating system residing within a central computer. Since the data base description does not need specialised programming effort, it makes it possible for less skilled users to become involved in the system design. A paper on the subject of parallelism in telescope and instrument control systems was given at the Workshop on Robotic Telescopes in Kilkenny. The use of optical gyroscopes as a means of stabilising compliant telescope mountings was examined further. The transfer of the Forth system from the VME bus environment of the William Herschel Telescope to the Apple Macintosh personal computer in order to provide a cheaper real time laboratory image acquisition and processing system for future detector developments was begun. This was completed up to the stage of a fully operational metaForth compiler, along with the main system source up to the assembler and real time event handling. New techniques of computer program documentation using advanced word processors to replace conventional editors were investigated. It was shown that it is possible to include program description and flow chart graphics all within one document and still retain efficient compilation of Forth systems. The technique could be applied to other languages, but would require extensions in that case.

3.9 Automatic Telescopes

I. G. van Breda

A paper was presented at the Kilkenny Workshop on Robotic Telescopes, outlining the importance of multi-wavelength photometric and spectroscopic monitoring of active galactic nuclei using automatic telescopes, with the aim of distinguishing between the black hole and starburst models for AGN. In particular, the detection of spikes due to supernovae is an important discriminant, especially when combined with spectroscopy, in determining the extent to which starbursts play a significant role in the central engine and whether or not there are evolutionary and luminosity effects. Combined with infrared observations, this would give an indication of the extent to which infrared emission is due to dust or synchrotron emission.

3.10 Data Analysis

I. G. van Breda

Work was carried out with a vacation student, Duncan Foster, on the transfer of data files relating to the strong Fraunhofer lines in the solar spectrum to the Sun workstation. These data were obtained originally using the Kitt Peak Fourier Transform Spectrometer. The user interface for a program for analysing interstellar extinction scanner was written.

4 Research Activities in the Geophysics Section

4.1 Gravity

P.W. Readman and T. Murphy, with University of Hamburg and British Geological Survey, Edinburgh

4.1.1 Onshore Gravity Surveys

The land gravity data set for Ireland is continually being added to and refined, and areas of sparse coverage filled in. This work was continued during 1992 along with the preparation for publication of the remaining 1/2 inch series (1 : 126 720 scale) of Bouguer Anomaly maps. Interpretation of the land gravity data during 1992 concentrated on anomalies in the eastern side of the country, mainly associated with the Leinster granite and its extensions.

The Geophysics Section, in collaboration with the British Geological Survey (BGS), contributed to the preparation and production of several regional gravity maps covering areas of Ireland and Britain, and further-a-field, Europe and parts of the former Soviet Union. The southern sheet of the Bouguer Anomaly map of Britain and Ireland and surrounding seas at a scale of 1 : 1 000 000 was published by BGS during 1992. Technical difficulties in the production of the smaller scale tectonic map of North West Europe with Bouguer Anomalies printed on the reverse side have delayed its publication and it has now been decided to produce that gravity map seperately but on the same scale and projection as the tectonic map. Gravity data for the south eastern part of the country was contributed to the Geological Survey of Ireland for use in the collaboration with the BGS within the EC-funded MIDAS programme. This project will integrate many types of geo-science data for an area of the Lower Palaeozoic of south east Ireland. We have also collaborated with the BGS in an application under the EC JOULE II programme to produce gravity and magnetic maps of north western Europe and to work on their regional interpretation. Data was also contributed to the West-East Europe Gravity Project, a project administered by the University of Leeds which seeks to collect all gravity data from western and eastern Europe, and from states of the former Soviet Union, to produce a unified series of maps.

4.1.2 Marine Gravity Surveys

The collaboration with the Geophysics Institute, University of Hamburg has continued. An improved method of data reduction for the marine gravity measurements from the COOLE and HOGS projects was developed and applied to the data from these surveys. The Eotvos correction was recalculated with higher accuracy and harsher data selection criteria applied. These data sets were merged with the most up-to-date DIAS and Northern Ireland land data and the BGS sea-bed data offshore north east Ireland. A map in which the grid interval has been reduced to 3 km (the optimum for the average line spacing used in the surveys) was prepared. The map shows similar basic features as the previous version but finer detail can now be resolved with greater confidence. The map in the Donegal Bay area in particular is more reliable and an anomaly near Valentia Island, which appears to be an extension of the large negative anomaly in Munster, has been determined in more detail. Preliminary interpretations of anomalies off the coast of Co. Clare, and also near to the eastern edge of the Rockall Trough along the most eastern line of the RAPIDS I seismic line were made.

Water depth information was added to the marine data files so that, in addition to the free air anomaly map for the marine areas which have so far been used with the Bouguer anomaly maps for the land areas, it is now possible to produce marine 'Bouguer' anomaly maps. Although this makes little difference to the overall appearance of the maps on the continental shelf it aids in the interpretation of anomalies associated with the steep continental slope of the eastern edge of the Rockall Trough.

4.2 Meteorology

K. Bolster

Readings and recordings of some of the meteorological elements were continued throughout the year. The resulting data was relayed to the Meteorological Service and published in its monthly Weather Bulletin. Enquiries are dealt with regularly and the long-term records are made available to researchers and students when requested.

4.3 Seismic Work

4.3.1 The Seismic Network (DNET and ENET)

T. A. Blake, K. Bolster, C. M. Horan, A. W. B. Jacob and G. Wallace

The analogue seismic network continued to operate and the triggered digital system (Seislog Earthquake Recording System, SERC) on the three DNET stations is well established. There were some problems on the analogue system, because of its age, and on the digital system, for rather different reasons. SERC communicates with the Geophysics Section and outside users via the telephone system and there were a number of line failures. These were finally traced to faulty telephone line connections on Lyons Estate. There were also problems with a remote reset box and with the hard disk. Both of these have had to be replaced. Grafplus was installed on PCs in the Section to provide hardcopy of seismic traces generated by SERC. The events are first displayed on screen and selected ones are printed.

An offer to supply and help install a digital broad-band seismic station at a site in Ireland has been made by the GeoForschungsZentrum (GFZ), Potsdam. The proposal is that it be put at our DLF site at Lyons Estate. It is hoped that this very valuable addition to our network can be installed in 1993.

There were two events in Ireland and an interesting one offshore to the south. On 12 April a small tremor, 0.5 ML, occurred in east Wexford Harbour. This was not felt but there were reports of an 1.5 ML event near Laragh, Co. Wicklow on 28 April. On 11 June there was an event in the Celtic Sea south of the Co Cork coast in an area previously quiet. The magnitude was 2.8 ML.

The largest regional event was near Roermond, Netherlands, on 13 April. This had a magnitude 5.9 ML and caused significant damage and some injuries. It was felt in Britain but not in Ireland. Other events over 3 ML occurred in the northern North Sea (8 November), near Peterborough (17 February) and near Caernarvon (29 July).

The most damaging earthquakes in 1992 were not particularly large. On 13 March a 6.2 Mb event occurred in Turkey and caused 500 deaths, many injuries and extensive damage. On 12 October a 5.9 Mb event killed 540 and injured 6500 in Cairo. Over 8000 buildings were damaged or destroyed. Damaging earthquakes are unusual but not unknown in the area and low building standards make Cairo very vulnerable. In contrast, a magnitude 7.4 earthquake in southern California on 28 June did not cause any deaths and about 200 were injured. It should be remembered that the magnitude scale is a logarithmic one. The heaviest casualties in 1992 were not the direct result of an earthquake but were caused by the resulting tsunami (*tidal wave*). This was in the Flores region of Indonesia on 12 December.

Many enquiries were dealt with during the year. Some concerned suspected tremors in Ireland and others came from Egypt, Iran, France, Portugal, Sweden, U.S.A. and the U.K.

4.3.2 Seismic Programme in Kenya - KRISP 90

A. W. B. Jacob and F. Hauser with European and American groups

Interpretation of the data continued in various centres. A special issue of Tectonophysics is being assembled with contributions from the Section to a paper on the structure of the Rift flank and another on seismic energy transmission inside and outside the Rift. A unified source magnitude scale has been developed, in which the size of the source and the efficiency of its seismic wave generation are taken into account. This has allowed us to measure the surprisingly large difference in attenuation between the Rift and its flanks. The difference is too great to be accounted for by intrinsic attenuation or by differences in geometrical spreading and is thought to be mainly due to scattering in a very fractured Rift crust. Attenuation in the mantle does not seem to vary significantly but the data set in this case is much smaller and more data are needed. Applications have been made to

extend the study of the Rift further to the south, possibly into Tanzania.

4.3.3 RAPIDS - Seismic Profiles in the Northeastern Atlantic.

A. W. B. Jacob, P. M. Shannon, F. Hauser, M. Callinan, B. O'Reilly and K. Stammler with UCD and the University of Hamburg

The model for the two profiles (1600 km long) was further developed. In particular, the model for the shelf immediately west of Ireland and the transition into the Rockall Trough is now at a similar stage to models for structures further west and within the Rockall Trough. A number of working visits were made to Hamburg and two workshops, in August and November, were held in the Geophysics Section. Geophysicists from the three groups, and Geologists from UCD, took part.

The RAPIDS model of the crust and mantle west from Ireland under the northeastern Atlantic is well enough defined to make it clear that the commonly accepted model of geological development in this region must be changed. This has implications for the Rockall Trough and its hydrocarbon prospectivity. The RAPIDS group have found that the major effects of the Iceland plume are very linear and have their greatest impact along the margin west of the Hatton Bank, nearly 1000 km WNW from Ireland. The effects of the plume do not spread evenly in all directions from the source.

These results, taken together with the crustal structures found by RAPIDS in the Rockall Trough, imply that we should revise our picture of the heat-flow history of the Trough and its margins. We now believe that there has been much less igneous intrusion into that crust, that the most severe heating was probably localized and not in the Trough, and that igneous sills have mainly intruded Cretaceous and Tertiary strata. Our conclusion is that the structure and thermal history of the Trough indicate that the petroliferous basin margins are not as disturbed by igneous intrusions as previously thought. Our model has implications for the understanding of mechanisms involved in the growth of oceanic margins elsewhere in the world. Only these wide-angle seismic techniques have so far been able to get a clear enough picture to arrive at these conclusions. Conventional reflection seismic approaches have failed to adequately penetrate beyond volcanic sills which are often thin but brightly reflecting.

4.3.4 Upper crustal seismic profiles in Co. Wicklow

G. Byrne, S. Dolan and staff of the Geophysics Section

Two useful, unreversed, seismic profiles were run north and northwest from a helpful quarry. This was a test for the 4.5 Hz geophones and provided data and experience for two summer students. Their undergraduate theses, which also used gravity data, gave interesting information on different aspects of the Leinster granites and showed that further study would be justified. It may, however, be difficult to satisfactorily reverse the lines.

4.3.5 General overseas and advisory work

A. W. B. Jacob, T. Blake, C. Horan, P. Readman, and G. Wallace

Early in the year, the Section advised the Universities of Madrid and Mexico City on underwater seismic sources for a project to study the seismic structure in southeastern Mexico, a very active seismic zone. G. Wallace travelled to Manzanillo to assist in their preparations. The Section also assisted in the LIMA project to study the Limagne Graben in the Massif Central in France. This took place in October and involved many of the groups we have worked with in Kenya. Useful experience was gained with equipment we will be using in future work.

Ireland has officially joined EUROPROBE, a European Science Foundation (ESF) initiative designed to tackle major geoscience targets *between the Atlantic and the Urals*. This is a successor to the European Geotraverse and the two aspects of it which will concern the Section are comparative studies of the Variscides and Uralides and the basic study entitled Deep Europe. A. W. B. Jacob attended an ESF Workshop in Nykoping, Falster, Denmark in September. Different methods of analysis were compared and used on the same data set.

4.4 Proposed study of the earth's core-mantle boundary

A. W. B. Jacob

A paper, further describing how a controlled source study of the core-mantle boundary might be carried out, and what the benefits might be, was presented at the EGS General Assembly in April. Recent palaeomagnetic research indicates

that movements in the liquid core have features with time constants as long as 15 million years. This is far too long to be controlled only by the core and there must be an input from the lower mantle. The core-mantle boundary is thus a very important interface whose topography could be one of the controlling influences. The Section, together with the University of Leeds and four other European institutions, has submitted an application to Brussels. It is proposed to apply lithospheric wide-angle techniques to the earth as a whole. Since the last Annual Report it has also become clear that the proposed sources should generate antipodal phases. A source near Portugal would be observable in the northern part of South Island, New Zealand. Australian seismologists have also expressed an interest in looking for PKP phases.

4.5 Palaeomagnetism

P. W. Readman with UCG and Amsterdam

Palaeomagnetic work, using the samples of Late Glacial sediments from Connemara and the Burren collected in collaboration with Dr. Michael O'Connell of the Botany Department, University College Galway and Dr. Sjoerd Bohnicke of the Free University of Amsterdam, has been performed at the Department of Geology and Geophysics, University of Edinburgh. The natural remanent magnetization of these samples is extremely weak and requires the use of a SQUID (Superconducting Quantum Interference Device) magnetometer in order to measure it with sufficient accuracy to have the possibility of being able to deduce geomagnetic secular variations. At present our work has been concentrated on one of the sites from the Burren area near to Gort as this has given the least scattered record of the NRM. It has also been the most extensively investigated from a palynological point of view. The results are promising but further work to investigate the stability and origin of the remanence needs to be done before variations in the direction of the geomagnetic field during Late Glacial times can be inferred.

5 Facilities

5.1 Track laboratories

Three of the Leitz Ortholux measuring microscopes were fitted with ASL linear displacement transducers and digital indicators. New or upgraded facilities developed during the year included a post-etch detector washing tank, a sodium hydroxide pumping system, an ammonia supply system for semi-automatic scanning and modular detector frames for the full-size etching tanks. The three main etching tanks, the microscopes and associated equipment were maintained and repaired as necessary.

5.2 Geophysics Instruments

G.A. Wallace, T.A. Blake, C.M. Horan

Most of the instrumental work during the year concerned the seismic networks and their maintenance. The remote telemetry station at Croghan (DCN) was recabled as the old cable, which ran along a field boundary, had been repaired a number of times. The new cable has been buried and should be less vulnerable.

The seismic field stations were all converted to use smaller 4.5 Hz geophones and were successfully used in a quarry blast programme during the summer. The data is recorded unaltered but can be played back through an amplifier which preferentially amplifies the lower frequency signals and produces a seismic trace similar to that from the more usual 1 or 2 Hz seismometers.

5.3 Computers

5.3.1 Networks

W. M. Tai, B. Jordan

The interconnection of all three sites occupied by the Institute to form a single local area network was completed during the year. The network is TCP/IP based and the various ethernet segments are linked through PCs running the public domain PC-Route software and 9.6kB SLIP lines. A further 9.6kB line links 5 Merrion Square to IEunet in TCD. Initial problems with the modems used on the links were eventually resolved by the installation of unbalanced attenuators.

A single class B internet address (160.6.0.0) was registered for the Institute and appropriate IP addresses assigned to all interfaces. Full connection to the global internet is planned for January 1993, but the bulk of e-mail traffic had already shifted to the internet by the end of the year. The SPAN connection to Frascati

continued to run without major complications and was moved to the new Vax3100.

5.3.2 X400 Services

W. M. Tai, L. Drury and M. Davey with D. O'Mahony (TCD)

The Institute was a subcontractor to TCD in a successful application to the European VALUE programme for funding to provide X400 services to the Irish research community. An X400 message transfer agent was installed and configured, and interoperability testing with the other Irish sites completed during the year.

5.3.3 Dunsink Observatory

I. Elliott, B.D. Jordan, W.M. Tai

A local ethernet network was set up with the Sun workstation as a fileserver and four PCs. Two of the old Tandon PCs were upgraded by installing 40MHz 386 mother-boards, new 40MB hard discs and high density floppy disc drives. The computer aided design software package, ORCAD, for drafting, circuit simulation and printed circuit artwork was installed on one of the PCs.

The contract with Bord Telecom for the leased line from Dunsink to the UCD Computer Centre was terminated with effect from 30 November (this service is now provided by the DIAS local area network and the link through TCD to UCD).

5.3.4 Merrion Square

T. A. Blake, W. M. Tai, D. Jordan and P. Hicks

It was decided to replace the old MicroVax II with a new Vax3100. This had the advantage that we could transfer all the existing product licenses and, at the same time, upgrade from version 4.6 of the VMS operating system to 5.5; this was achieved eventually, but only after considerable correspondence. The second major advantage of this change is that it has enabled us to standardise on SCSI as the interface for all tape and disc drives (excluding those in PCs). With the move towards a more standardised and distributed system it has been possible to substantially reduce the level of maintenance contracts thereby freeing resources for more productive uses.

The cosmic ray section installed several PCs as X-terminals during the year to provide additional astronomical image display capacity. The various standard packages (MIDAS, IRAF, TeX etc) were maintained and supplemented with many utilities to provide a flexible and powerful environment for general computing as well as image processing.

The Geophysics Section acquired a Sun IPC and a Dell 486 PC for seismic analysis. Upgrades to the VME hardware and software were discussed with the British Geological Survey in Edinburgh. K. Stammler worked on further developments of the Seismic Handler package in September.

6 La Palma Observatory

6.1 General

There have been several changes in the composition of the La Palma Advisory Committee (LPAC) following the retirement of Professor Wayman. T.P. Ray has taken over the post of Secretary of the committee and is in charge of liaison with the SERC. Dr. M. Redfern is now the Royal Irish Academy representative replacing Dr. M. de Groot and Dr. de Groot has been asked by the Governing Board to stay on LPAC in an advisory capacity. Prof. Drury replaces Prof. Wayman as the DIAS representative.

Professor B. McBreen has come to the end of his period of service on the Panel for Allocation of Telescope Time (PATT) and the new Irish PATT representative is Prof. T. Ray who serves on the Isaac Newton Group Time Allocation Committee (TAC). PATT itself met twice during the year in June and December, on both occasions in Coventry. As can be seen from the reports below detailing observing runs during the year, Ireland continues to enjoy substantial allotments of time on what are first class world instruments. Additional allocations on other (non-SERC) telescopes are also listed. Bad weather conditions unfortunately afflicted several major projects.

Recognizing the importance of the La Palma project, EOLAS has continued to provide financial support on an annual basis in addition to the funding deriving from DIAS. At a meeting of LPAC representatives with the EOLAS chief executive Dr. Brendan Finucane and Dr. Conor O'Toole, the boost to Irish astronomy provided by the La Palma agreement was noted with appreciation.

Access to an enormous number of catalogues and space observatory data (for example from IUE, IRAS, HST and ROSAT) can now be obtained on-line through DIAS using the STARCAT facility. Data storage is located at the ESO/Space Telescope Coordinating Facility Headquarters in Munich but access is through a menu-driven user interface installed locally thus minimizing the amount of information sent via the network.

6.2 Observing Runs 1992

6.2.1 SERC Telescopes

B. McBreen (UCD) et al. , " Spectroscopic Observations of Blue Compact Dwarf Galaxies", one Grey/Dark Week, INT

Observations of a number of blue compact galaxies were carried out using the INT with the intermediate dispersion spectrograph to look for an "old" component. One night was lost due to a telescope malfunction and two other nights suffered from poor weather. Good data was obtained on the remaining four nights by the observer, Simon Steel of UCD.

S.C. Russell (DIAS), "Lithium Abundances in δ Scuti Variables", six Bright Nights, JKT

Russell obtained spectra of the Lithium I 6707Å region in about 20 δ Scuti stars with very high signal to noise.

R.M. Redfern (UCG), "Post-collapse Cores of Globular Clusters Using Image Sharpening", five Grey/Bright Nights, WHT

The combination of the UCG/DIAS image sharpening camera, TRIFFID, with the RAL PCD detector was used on the imaging laboratory of the WHT for the first time. The run was very successful and it is expected to achieve a final resolution of about 0.25" in the case of M 15.

S. Russell (DIAS): (W/W/46) "Accurate Lithium Abundances in Young Open Cluster K Stars", WHT, three nights. Eight programme stars from the Pleiades were successfully observed; including one star from the α Persei cluster, three stars from the Hyades to act as comparison stars and several spectral standards were also obtained.

M. Redfern (UCG) et al. : (W/W/70) "Image Sharpening of the Wisp Structure Around PSR 0531+21", WHT, three nights. Conditions during this run were very poor and no useful observations were made. As the UES was dismantled, it was it not possible to carry out the proposed backup programme.

B. McBreen (UCD) and M. Rabbette (UCD): (J/W/2) "Time-resolved CCD Photometry of Blazars", JKT, one week.

6.2.2 Non SERC Instruments

The UCG/DIAS/ICL/RAL image sharpening camera TRIFFID was mounted on the New Technology Telescope (NTT) in ESO Chile towards the end of August. During this run the seeing conditions were described as very poor and in five nights only some intermittent observations were made. There were also some mechanical problems with the NTT itself. A total of six hours of data on the globular cluster 47 Tuc was obtained. A further run was planned for January 1993.

T.P. Ray (DIAS) " A Search for Disks Around Post T Tauri Stars", Caltech Submillimeter Observatory, four nights.

The weather conditions were very good for millimeter work throughout this run. Direct evidence has been found that proto-planetary disks around young stars evolve rapidly as a star passes from the classical T-Tauri phase to the post T-Tauri phase. Observations of a large number of Herbig Ae/Be stars also proved to be successful with circumstellar dust being detected around most of them.

Ray, Moorhouse and Bastien (University of Montreal) had a run of three nights in November on the Canadian French Hawaiian Telescope CFHT) using the new infrared camera MONICA. Blizzards wiped out the majority of the time and a total of two and a half nights were lost. In the remaining half night polarization images at K and direct imaging at J, H and K bands were taken of two pre-main sequence stars. The data showed that that this project is feasible with this instrument.

7 Seminars, Colloquia, Lectures

7.1 Statutory Public Lecture

Profesor M. W. Feast (University of Cape Town) delivered the Annual Statutory Public

Lecture at Trinity College, Dublin on 7 May. The lecture was entitled "The Centres of Galaxies".

7.2 Seminars in the School

- J. Luetgert (U.S. Geological Survey, California) gave a seminar on 28 January entitled "Seismic Studies of crustal structure in the Appalachians".
- A. Raga (Manchester) gave a seminar in March on "YSO variability: how to produce knotty jets".
- M. Burton (Anglo-Australian Observatory) gave a seminar entitled "Explosive Ejection associated with Star Formation in Orion".

7.3 Contributions to Scientific Meetings

- T. Ray spoke on the evolution of discs around young stars at the Autumn ASGI meeting.
- T. Ray gave an invited review on the subject of jets from young stars at the Space Telescope Science Institute's meeting on astrophysical Jets in Baltimore in May.
- D. O'Sullivan delivered talks on early results from the ultra heavy cosmic ray experiment at Dubna and San Diego and gave an invited talk at the Cospar Meeting in Washington.
- T. Kiang spoke on *Distance, Velocity and Redshift in the Expanding Universe* and *Understanding the Expanding Universe* at Astronomical Science Group Meetings in Galway on April 16 and at Dunsink on October 6 respectively
- I. Elliott spoke on "William E. Wilson and Daramona Observatory" at the ASGI meeting in Dunsink, 6 October.
- A. W. B. Jacob, Spectral aspects of seismic phases, ESF EUROPROBE Workshop in Nykobing, Falster, Denmark, 28 September 1992.
- A. W. B. Jacob, A controlled source study of the earth's core-mantle boundary, Seismic Workshop, USGS Menlo Park, California, 5 December.
- F. Hauser et al., RAPIDS Project:seismic structure of the crust under the Rockall Trough, European Geophysical Society XVII General Assembly, Edinburgh, 6-10 April.
- U. Vogt et al., The continental margin west of Ireland: new wide-angle reflection and refraction results, European Geophysical Society XVII General Assembly, Edinburgh, 6-10 April.
- L. Drury spoke on "The Gamma-ray Visibility of Supernova Remnants" at the Autumn ASGI meeting in Dunsink.

7.4 Lecture Courses

- T. Ray gave his lecture course to Senior Sophister Physics students in TCD on Plasma Astrophysics.
- D. O'Sullivan gave a course of eight lectures on cosmic ray astrophysics to 3rd year students at Trinity College during Hilary term.
- T. Kiang gave a U.C.D. Adult Education Course of ten lectures entitled "Understanding the Expanding Universe" in St. Patrick's College, Drumcondra.
- I. Elliott gave a course of 16 lectures on Introductory Astrophysics at Junior Sophister level in Trinity College.
- I. Elliott gave two courses of 10 lectures each in the UCD Adult Education Programme on "Astronomy Now" (Spring Term) and "An Introduction to the Solar System" (Autumn Term).

7.5 External Seminars

- D. O'Sullivan delivered a seminar on rare nuclei in the cosmic radiation at St. Patrick's College, Maynooth, on October 15.
- F. Hauser spoke on Crustal Structure along the Fennolora Line in UCD, 10 February.
- A. W. B. Jacob spoke on Earthquakes and their Impact to the Insurance Institute of Cork, 5 October.
- T. Ray spoke on jets from young stars in Stockholm Observatory in April.

7.6 Popular Lectures

- T. Ray spoke to the Cork Astronomical

Society and to the Irish Society of Surveying Photogrammetry and Remote Sensing.

- The astronomical significance of Newgrange was the subject of talks given by T. Ray to the delegates at the 26th Eslab symposium in Killarney in June and the IAU Colloquium 136 in August.
- D. O'Sullivan presented a talk at the RDS summer school for second level students in August.
- T. Kiang addressed Astronomy Ireland on *Understanding the Expanding Universe* on January 27.
- I. Elliott spoke on "The Golden Age of Astronomy in Ireland" to the Cork Literary and Scientific Society on 22 October.
- I. Elliott continued the series of lectures sponsored by the Institute of Physics by speaking on "Astronomy in the Teaching of Physics" to branches of the Irish Science Teachers Association in Cork (4 February), Wexford (23 March) and Sligo (1 April).
- I. Elliott contributed to the 1-day course for secondary teachers held in 10 Burlington Road on 7 March.
- I. Elliott lectured H. Dip. Ed. students in the UCD Education Department on the Junior Cycle environment course (11 Feb).

8 Organisation of Meetings

8.1 The 26th ESLAB Symposium

Local Organising Committee: P. K. Carroll, S. McKenna-Lawlor, B. O'Donnell, C. O'Toole, A. Thompson

Preparation for the 26th ESLAB Symposium (The Study of the Solar-Terrestrial System) and associated activities continued during the first half of the year. The Symposium, which took place in Killarney, 16-19 June, was organised by the Space Science Department of ESA (the European Space Agency) in collaboration with the Dublin Institute for Advanced Studies and EOLAS. This was the first time that ESA had organised a major space science conference in Ireland and an opening address was given by Professor R. M. Bonnet, Director of the Scientific Programme of ESA.

The Symposium was centered in the Hotel Europe (located on the largest of the Killarney lakes) which has excellent conference facilities. Much of the organisation work both before and during the conference was carried out by Ms G. Broderick and Ms S. Ledwidge of the Cosmic Ray Section, who were members of the six-strong Secretariat, along with two staff members from EOLAS and two from the Space Science Department of ESA. Cluster and SOHO Science Working Team meetings were held in the same location immediately preceding the Symposium. The Cluster and SOHO (Solar Heliospheric Observation) Missions are central to the ESA Solar-Terrestrial Science Program (STSP) which is the first "cornerstone" of ESA's "Space Science: Horizon 2000" plan. With regard to the main scientific programme of the Symposium a novel approach was implemented. Instead of the three classical domains of solar, interplanetary and magnetospheric physics, the scientific programme was structured according to plasma physics processes ocurring in the different regimes at different scale lengths and with different parameters.

In addition to the scientific programme an extensive social programme was organised. Just prior to the Conference Banquet on 17 June, an invited lecture on the Neolithic passage graves at Newgrange was given by Professor T. Ray of the Cosmic Ray Section, finally revealing the background to the triple spiral which was the logo for the Symposium.

The Proceedings were finalised and published in September by the ESA Publications Division at ESTEC. In addition to the Proceedings, a book is planned with contents following the original symposium structure. The aim is to create an up-to-date reference book for solar-terrestrial physics, oriented to the cross-fertilisation of the two communities collaborating in ESA's first cornerstone programme (solar and space plasma/magnetospheric physics) and to give newcomers to the field, the graduate students of the late 1990's, an informative and readable exposure to this rich field of physics.

8.2 IAU Colloquium 136, Stellar Photometry – Current Techniques and Future Developments

Local Organising Committee: P. A. Wayman (Chairman), I. Elliott (Secretary), D. L. Weaire, E. O'Mongain and C. J. Butler

The IAU Colloquium 136 on Stellar Photometry took place in Trinity College in the first week of August 1992 as part of the Quatercentenary celebrations of the College. The meeting marked the centenary of the first electrical measurements of starlight which were made in Dublin on 1892 August 28 by W. H. S. Monck in collaboration with G. M. Minchin, G. F. Fitzgerald and S. M. Dixon. The meeting was sponsored by Commission 9 (Instruments and Techniques) and Commission 25 (Photometry and Polarimetry) of the International Astronomical Union which granted it colloquium status. The local sponsoring institutions were the Royal Irish Academy, the Dublin Institute for Advanced Studies, Trinity College and Armagh Observatory. The general aim of the Colloquium was to assess current techniques and to look forward to future developments. The scientific programme was drawn up by a 12-member scientific organising committee chaired by Dr Andrew T. Young, President of Commission 25; I. Elliott acted as SOC secretary.

Over 300 replies were received following the mailing of the First Announcement and there were numerous requests for financial support, especially from astronomers in the former Soviet Union. The occurence of postal and banking disputes at a crucial time created many difficulties but these were largely overcome by extensive use of electronic mail. The Colloquium was attended by 128 registered participants and 23 guests. The work of the Colloquium was carried out in seven sessions which dealt with photometric systems, high precision photometry, new techniques, automatic telescopes, global networks, CCDs and Space. About fifty poster papers were displayed in a room adjacent to the coffee room. A trade display of detectors was mounted in the poster room for one day.

Excursions were arranged for Wednesday afternoon to the Boyne Valley and Glendalough followed by a reception at Dunsink Observatory. On Thursday there was a Civic Reception in the Mansion House. The guest speaker at the Banquet in the College Dining Hall on Friday evening was Prof. Gordon Herries Davies. On Saturday, 8th August, some thirty participants took a coach tour to Armagh where they visited the County Museum, the cathedrals, the Planetarium, the Observatory and Navan Fort.

The Colloquium was preceded by a three-day Workshop on Robotic Observatories which was held in the Newpark Hotel, Kilkenny, 29-31 July. The Workshop was organised by Russell Genet of Fairborn Observatory, Arizona and I. Elliott. It attracted 27 participants and 12 guests, most of whom also participated in the Colloquium. On the first evening there was a walking tour of Kilkenny which was followed by a Civic Reception in the Butler House; the visitors were given a cordial welcome by the Mayor of Kilkenny, Mr. Seamus Pattison, T.D. There was also a half-day excursion to Birr Castle. The Workshop closed with a barbeque at Mount Juliet following a short visit to the picturesque village of Inistioge, the scene of Monck's childhood.

One of the chief aims of the organisers of the Colloquium was to bring together experts from East and West and this was facilitated by a grant from the International Astronomical Union towards the travel and subsistence expenses of thirteen participants. Generous local support was also received from the following: Aer Lingus, Bord Failte, EOLAS, Bristol Myers Squibb, the Royal Irish Academy, Siemens Ltd., Ulster Bank Ltd., Optronics Ireland, Easons Ltd., Fred Hanna Ltd., AGB Scientific, Mason Technology, T.K. Laidlaw, R.G. Tennant and T.S. Maharry.

The running of the Colloquium was greatly assisted by a dozen students who helped at the reception desk, in the lecture theatre and in the poster room. Many participants commented favourably on the warm welcome they received.

The main proceedings of the Colloquium will be published by Cambridge University Press with C.J. Butler and I. Elliott as editors and the poster papers will be published separately by the Dublin Institute for Advanced Studies. In order to obtain rapid production of the papers in camera ready form, a standard LaTeX format was adopted and more than half the participants submitted their contributions in the approved way. The proceedings of the Kilkenny Workshop will be published by Ellis Horwood with Prof. M.F. Bode and Dr B.P. Hine as editors.

8.3 EADN Summer School

T. Ray with S. Beckwith (MPIA, Heidelberg)

A Summer School on Star Formation was organised under the auspices of the European Astrophysical Doctoral network. The School was held in the Technical University of Berlin and was attended by approximately 60 postgraduate students. Seven lecture courses were given and there were some 40 short presentations by the participating students. A. Grace of the Cosmic Ray Section served as school secretary. The proceedings will be published by Springer Verlag in their Lecture Notes in Physics series.

8.4 One Day Course on Astronomy and Meteorology for Teachers

T. Ray (Organiser), I. Elliott, S. Russell, P. Wayman with J. Rogers (Meteorological Service)

Astronomy and Meteorology are now part of the environmental science curriculum. In co-operation with the Association of Science Teachers of Ireland a one-day course was arranged on 7 March to introduce these subjects to teachers. Some 50 teachers attended and, apart from the new course material, they were also given a flavour of the research being carried out in DIAS and the Meteorological Service.

8.5 Astronomical Science Group of Ireland

S Russell

The Spring meeting of the ASGI was held in UCG with guest speaker Dr. A. Young (ESO). The Autumn meeting was organised to mark Professor P.A. Wayman's retirement and was held in Dunsink Observatory. Several former scholars and associates gave talks outlining Professor Wayman's influence on their work and a small presentation was made after the meeting.

9 External Work

9.1 Astronomy Section

P. A. Wayman: 10 January and 13 November, Attendance at R. Astr. Soc., London; 6-16 January, M.W. Feast Symposium at Cape Town, S. Africa; 17 January, Address at Physics Dept., University of S. Africa, Pretoria, on 'Astronomy in S. Africa from the 1950's - a Personal Account'; 7 March, Address to ASTI Conference on 'Calendars'; 23 March, Chairman, Meeting of Scientific Instruments Committee meeting, UCC; 1 April, Talk to Astronomy and Astrophysics Soc., UCG, 'The Total Solar Eclipse of 11 July 1991'; 4 April, Talk at IAS 'Astrofest', Tullamore, 'Gravity in Astronomy'; 6 April, Talk at Cork Astronomy Club, *The Total Solar Eclipse of 11 July 1991.*; 16 April, Contribution to ASGI Meeting, UCG, *A Croagh Patrick Alignment*; 29 July, Opening Address, Kilkenny Workshop; 7 August, Chairman, IAU Colloquium 136, a.m. Session; 5 October, IAS, Dublin, *Some Years in Astronomy at Dunsink*; 12 October, R. Irish Academy Discourse, *The Big Bang - Fact or Fiction.*

I. Elliott: The 26th ESLAB Symposium on Study of the Solar-Terrestrial System, Killarney 16-19 June 1992.

9.2 Cosmic Ray Section

T. Ray: January, United Kingdom Infrared Telescope, Hawaii; January, Max-Planck-Society telescope in La Silla, Chile; April, Collaboration with G. Gahm in Stockholm; April, Caltech Submillimeter Observatory, Hawaii; May, Space Telescope Science Institute meeting on Astrophysical Jets, Baltimore;June, EADN board meeting, Paris; June, Eslab Symposium, Killarney; July, 2nd Hubble Space Telescope workshop, Sardinia; September-October, EADN Summer School, Berlin; December, PATT meeting, Kenilworth

L. O'C. Drury: 28 Jan AWG Paris; 7 April, Archiving review team meeting, ESTEC, Holland; 16 April ASGI Galway; 12 - 14 May, AWG, Capri, Italy; 18 - 23 May, Vulcano workshop, Vulcano, Italy; 3 - 5 June, ISO star formation meeting, Stockholm, Sweden; 15 June, Cluster meeting, Killarney; 19 June, Particle acceleration proposal meeting, RAL, England; 26 - 27 June, Star formation proposal meeting, Brussels, Belgium; 24 August - 5 September, MPIK, Heidelberg, Germany; 6 - 12 Sep, Ringberg workshop, Germany.

A. Grace: EADN board meeting, Paris, 14-16 June; EADN Summer School, Berlin, 20-27 September.

D. O'Sullivan: International Workshop on Applications of Solid State Nuclear Track Detectors, Dubna, March 24-26. Second LDEF Post Retrieval Symposium, San Diego, June 1-5. Giotto Extended Mission (GEM) activities, Darmstadt June 27-30 and July 6-12. Cospar Meeting and World Space Congress, Washington, August 28-September 5. First experimenters meeting, IRMA Project, Brussels, October 2. NASA Space Physics Division Review Panel, November 9, 10, 11. Calibration run at Berkeley Bevalac, December 10-16. In addition, two meetings were attended in Ireland at Tralee (IOP Spring Meeting, 10-12 April) and at Killarney (26th ESLAB Symposium, 16-19 June).

S. Russell: 14-20th May, Observing on JKT *Lithium Abundances in Delta Scuti Variables*; Outcome - Started poorly, but obtained 3 good nights of observations. 11- 18th Jun, ISO open time proposals work in Heidelberg; 28th Aug - 1st Sept, Observing on SEST *A millimetre continuum survey for the youngest protostars: an ISO ground-based preparatory programme* Outcome - poor weather, but some significant results obtained;

A. Thompson: The 26th ESLAB Symposium, Killarney, 14-18 June; Giotto Extended Mission - Encounter with Comet Grigg-Skjellerup, ESOC, Darmstadt, 8-11 July

G. Broderick: Conference preparation work, Killarney, May; The 26th ESLAB Symposium, Killarney, 14-19 June.

S. Ledwidge: Conference preparation work, Killarney, May; The 26th ESLAB Symposium, Killarney, 14-19 June.

J. Byrne: Calibration run at Berkeley Bevalac, 10-16 December.

9.3 Geophysics Section

T. A. Blake: EGS XVII General Assembly, Edinburgh 6-10 April; DECUS Conference, Dublin City University, 2-4 September; Limagne Graben experiment, France, 8-26 October; BGS Edinburgh re seismic network software and hardware.

K. Bolster: seismic data processing, BGS Edinburgh, 4-10 March.

M. Callinan: RAPIDS visit to Hamburg, 17-28 February; EGS XVII General Assembly, Edinburgh 6-10 April.

F. Hauser: RAPIDS visits to Hamburg, 17-28 February, 22-31 July, 16 November - 12 December; EGS XVII General Assembly, Edinburgh 6-10 April.

C. Horan: Limagne Graben experiment, France, 8-26 October.

A. W. B. Jacob: planning meeting Lisbon and data collection, Aldermaston, 12-15 January; EGS XVII General Assembly, Edinburgh 6-10 April; EC, Brussels 23-26 February; seismic data processing, BGS Edinburgh, 4-10 March; planning meeting, Leeds, 1-2 June; RAPIDS visits to Hamburg, 11-18 June, 23-28 November; EUROPROBE Workshop, Denmark, 26 September - 4 October; EGS meeting Frankfurt and visit to Univ. Karlsruhe, 2-5 November; AGU Meeting, San Francisco and Workshop, Menlo Park, 4-14 December.

T. Murphy: EGS XVII General Assembly, Edinburgh 6-10 April; Offshore gravity assessment, Hamburg, 23-30 November.

B. M. O'Reilly: AGU Meeting, San Francisco, 5-13 December.

P. W. Readman: EGS XVII General Assembly, Edinburgh 6-10 April; palaeomagnetic measurements, University of Edinburgh, 4-10 February; Limagne Graben experiment, France, 8-26 October; work on offshore gravity, Hamburg, 16 November - 11 December.

P. M. Shannon: RAPIDS visit to Hamburg, 11-13 June and 23-25 November.

G. Wallace: seismic survey in Mexico, 23 February - 2 March.

10 Miscellania

I. Elliott and W. Dumpleton prepared an exhibit for the Dublin Science Festival at the RDS, 1-3 October. The exhibit included star shows in an inflatable planetarium and several students assisted on the stand.

At the invitation of Sabino Maffeo S.J. Brendan Jordan paid a short private visit to the

Vatican Observatory, Castelgondolfo, Rome in August.

A. W. B. Jacob was appointed General Secretary of the European Geophysical Society in April.

L. Drury was elected Chairman of the national Committee for Physics.

T. Ray was appointed a member of the Space Telescope Advisory Team. He was also appointed to the Infrared Space Observatory Time Allocation Committee and the Panel for Allocation of Telescope Time. He became secretary of the local La Palma Advisory Committee and is the DIAS nominee to the National Committee for Astronomy.

10.1 Trinity College Quatercentenary.

The exhibition concerning the 400-year history of Trinity College, Dublin, entitled "Treasures of the Mind", included a display of items illustrating the private study of William Rowan Hamilton. Items from Dunsink, some of which had been the personal property of Hamilton, were lent for the occasion and other assistance given.

10.2 EXPO92, Seville, Spain.

Advice was given to the organisers of the Irish Pavilion and several items, including the historic Grubb coelostat and the flight-spare cylinder from the Ultra-Heavy Cosmic Ray Experiment, were provided on loan for the duration of the exhibition (April to October).

11 Publications

11.1 Journals

S. C. Russell and M. A. Dopita: *Abundances of the Heavy Elements in the Magellanic Clouds, III, Interpretation of Results*, Ap.J., **384**, 508-522 (1992).

P.A. Wayman with A. N. Argue, P. S. Bunclark, M. J. Irwin, P. Lampers and D. Sinachopoulos: *Double Star CCD Astrometry and Photometry*, MNRAS, **259**, 563-568 (1992).

S.-P. Xiang and T. Kiang: *Density perturbations of baryons in a Universe dominated by multiple dark matter*, MNRAS, **259**, 761 (1992).

B. Jordan with M. Redfern, A. Shearer, P. O'Kane, C.O'Byrne, P. Read, M. Carter and M. Cullum: *First Scientific Results from TRIFFID*, Gemini, Dec (1992).

I.G. van Breda with M.K. Carter, B.E. Patchett, P.D.Read and N.R. Waltham: *New techniques in photon counting detectors*, Nucl. Inst. and Meth., **A310**, 305-310 (1991).

I.G. van Breda: *Halation in Image Intensifiers*, MNRAS, **257**, 415-418 (1992).

A. Thompson and D. O'Sullivan with S. McKenna-Lawlor, V. V. Afonin, K. I. Gringauz, K. Kecskemety, E. Keppler, E. Kirsch, A. Richter, P. Rusznak, K. Schwingenschuh, A. J. Somogyi, L. Szabo, A. Varga, Y. Yeroshenko and M. Witte: *Energetic Particle Studies at Mars by Sled on Phobos-2*, Adv. Space Res., **12**, 9231-9241 (1992).

L. O'C. Drury with H Kang: *A comparison of models for supernova remnants including cosmic rays*, ApJ, **399**, 182-184 (1992).

A. Moorhouse with M.G. Burton, M. Bulmer, T.R. Geballe and P.W.J.L. Brand: *Fluorescent Molecular Hydrogen Line Emission in the Far-red*, MNRAS, **257**, 1p (1992).

A. Moorhouse with A.C.Chrysostomou, P.W.J.L. Brand and M.G. Burton: *The Structure of Photodissociation Regions: M17 Northern Bar*, MNRAS, **256**, 528 (1992).

T.P. Ray with R. Poetzel and R. Mundt: *Herbig-Haro Outflows Associated with MWC1080 and AFGL2591*, Astron. Astrophys., **262**, 229 (1992).

T.P. Ray with W.J. Zealey, P.M. Williams, G. Sandell, and K.N.R. Taylor: *Molecular Hydrogen Complexes in Herbig-Haro Complexes*, Astron. Astrophys., **262**, 570 (1992).

F. Hauser and A. W. B. Jacob with P. M. Shannon and J. Makris: *RAPIDS Project: seismic structure of the crust under the Rockall Trough along a 600 km axial line*, Annales Geophysicae, **10**, C66 (1992).

A. W. B. Jacob with U. Achauer et al: *Some remarks on the structure and geodynamics of the Kenya Rift*, Tectonophysics, **213**,257-268 (1992).

A. W. B. Jacob: *A controlled source seismic study of the core-mantle boundary?*, Annales Geophysicae, **10**, C50 (1992).

A. W. B. Jacob with G. Keller et al: *Kenya Rift International Seismic Project, 1989-1990 Experiment*, EOS, **73**, 345-351 (1992).

A. W. B. Jacob, J. Makris, P.M. Shannon, U. Vogt, F. Hauser and B.M. O'Reilly: *Lithospheric Dynamics and the Opening of the North Atlantic*, EOS, **73**, 553 (1992).

A.W.B. Jacob with U. Vogt, J. Makris and P.M. Shannon: *The continental margin west of Ireland: new wide-angle reflection and refraction results*, Annales Geophysicae, **10**, C66 (1992).

P.A. Wayman with G.G. Bracken: *A Neolithic or Bronze-Age Alignment for Croagh Patrick*, Cathair na Mart, **12**, 1-11 (1992).

11.2 Conference Proceedings

L. O'C. Drury: *Cosmic Ray Acceleration*, Proc Cargèse Workshop, June 1991, Collective Acceleration in Collisionless Plasmas, ed D le Queau, A. Roux and D. Gresillon, Les Editions de Physique (1992).

L. O'C. Drury: *Cosmic ray acceleration in supernova remnants*, AIP Conference Proceedings, **264**, 189–194, ed G. P. Zank and T. K. Gaisser, Particle Acceleration in Cosmic Plasmas, Newark 1991.

S. Russell: *Magellanic Cloud Research with ISO*, The Heidelberg Conference on New Aspects of Magellanic Cloud Research, June 15-17th, 1992.

S. Russell: *Our Present Understanding of the Chemical Compositions of the Magellanic Clouds*, The 3rd DAEC Meeting in Paris on The Feedback of Chemical Evolution on the Stellar Content of Galaxies, Oct 12-16th, 1992.

S. Russell with C. Ceccarelli, M. Griffin, P. André, P. Saraceno and S. Molinari: *On the nature of Class I sources in ρ Ophiuchus*, The VIth GIFCO Congress, Palermo (Italy), 3-6th Nov 1992.

A. Thompson, D. O'Sullivan, J. Bosch, R. Keegan, K.-P. Wenzel, F. Jansen and C. Domingo: *Progress Report on the Ultra Heavy Cosmic Ray Experiment (A0178)*, Proceedings of the Second LDEF Post-Retrieval Symposium (San Diego, California), **1**, 261-268 (1992).

D. O'Sullivan and A. Thompson with E. Kirsch, S. McKenna-Lawlor, V.V. Afonin, K. Schwingenschuh, E. Keppler and M. Witte: *Observation of Particle Bursts in the Tail of Planet Mars onboard the Phobos-2 Spacecraft*, Proceedings of the 26th ESLAB Symposium (Killarney, Ireland), ESA SP-346, 177-180 (1992).

A. Thompson and D. O'Sullivan with E. Kirsch, S. McKenna-Lawlor, V.V. Afonin, E. Keppler, S. Livi, H. Rosenbauer, M. Witte and K. Schwingenschuh: *Signatures of the Martian moons Phobos and Deimos in the particle and magnetic field measurements of the experiments SLED, TAUS and MAGMA onboard Phobos-2*, European Geophysical Society 17th General Assembly (Edinburg), PS16-P6, April 1992.

D. O'Sullivan and A. Thompson with S. McKenna-Lawlor, E. Kirsch, P.K. Daly and K.-P. Wenzel: *Planned Investigations during the P/Grigg-Skjellerup Encounter using the energetic particle analyser EPONA on the Giotto Extended Mission*, EGS 17th General Assembly, PS7-4, April 1992.

R. Keegan, D. O'Sullivan, A. Thompson, J. Bosch, K.-P. Wenzel, F. Jensen and C. Domingo: *Preliminary Results from the Ultra Heavy Cosmic Ray Experiment on LDEF*, Proceedings of the 1992 Dubna International Workshop, April 1992.

A. W. B. Jacob: *The RAPIDS Project - a seismic profile in the Atlantic west of Ireland*, Proc. 5th Lough Beltra Workshop, 32-42 (1992).

T. Murphy with G.A. Day et al: *1:1 000 000 Bouguer anomaly map: Southern Britain, Ireland and adjacent seas*, publ. British Geological Survey, 1992.

A.W.B. Jacob with C. Prodehl, E. Dindi, R. Stangl and H. Thybo: *Crustal structure of the eastern flank of the Kenya Rift*, Spannung und Spannungsumwandlung in der Lithosphaere (ed. Fuchs, Althaus, Altherr and Prodehl), 309-338 (1992).

P.W. Readman with G.A. Day et al: *A new gravity map of NW Europe*, XVII General

Assembly of the European Geophysical Society, Edinburgh, 6-10 April, 1992.

P.W. Readman with G.A. Day and J.W.F. Edwards: *A new offshore gravity map of North West Europe*, Joint Annual Meeting of the Geological Association of Canada and the Mineralogical Society of Canada, Wolfville, Canada, 25-27 May, 1992.

P.W. Readman with G.A. Day and J.W.F. Edwards: *A new marine gravity map of North Western Europe*, in *The Tectonics, sedimentation and palaeoceanography of the North Atlantic Region*, Geol. Soc. London, Edinburgh, 28-29 September, 1992.

I. G. van Breda: *Monitoring of Active galactic Nuclei*, Workshop on Robotic Telescopes, Kilkenny, 1992.

I. G. van Breda: *Parallelism in Telescope and Instrument Control Systems*, Workshop on Robotic Telescopes, Kilkenny, 1992.

I.G. van Breda, M.K. Carter, B.E. Patchett, and P.D. Read: *The Rutherford Appleton Laboratory Photon Counting Detector*, ESA Symposium on Photon Detectors for Space Instrumentation, Noordwijk, 1992.

11.3 Reports and Articles

A. W. B. Jacob: *Seismology Report to the Irish National Committee for Geodesy and Geophysics*, April 1992.

A. W. B. Jacob: *RAPIDS Report to EOLAS*, Year 1992.

P.A. Wayman: *A Second Newton: William Rowan Hamilton, mathematician and astronomer*, Treasures of the Mind, ed. D. Scott, Trinity College Dublin Exhibition, Sotheby's, 57-77 (1992).

I. Elliott contributed a regular monthly article, *Skynotes*, to Technology Ireland.

11.4 The Irish Astronomical Journal

P. A. Wayman: *Dunsink Observatory - A policy for the 1990's*, **20**, 270-271 (1992).

S.-P. Xiang and T. Kiang: *A standard cosmological model with multiple dark matter*, **20**, 268 (1992).

S.-P. Xiang and T. Kiang: *Big Bang: galaxy formation from random initial density perturbation*, **20**, 290 (1992).

T. Kiang: *A Diagram Illustrating the Resolution of the Twins Paradox*, **20**, 201 (1992).

T. Kiang: *A Tool for Researching into the Shape of Things*, **20**, 267 (1992).

I. Elliott and M. T. Brück: *The Family background of Lady Huggins*, **20**, 210 (1992).

P.A. Wayman: *Collaboration between Armagh and Dunsink Observatories over 200 years, 1790-1990*, **20**, 251-263 (1992).

INSTITIÚID ARD-LÉINN BHAILE ÁTHA CLIATH

(Dublin Institute for Advanced Studies)

FINANCIAL STATEMENTS FOR YEAR ENDED 31 DECEMBER 1992

CONTENTS

INSTITIÚID ARD-LÉINN BHAILE ÁTHA CLIATH

(Dublin Institute for Advanced Studies)

1992

GENERAL

The Institute was established under the Institute for Advanced Studies Act, 1940.

Its functions include the provision of facilities for the furtherance of advanced studies and the conduct of research in specialised branches of knowledge.

It comprises three Schools - Celtic Studies, Theoretical Physics and Cosmic Physics.

ACCOUNTING POLICIES

1. Accounting basis:

   The Accounts have been prepared under the historical cost convention.

2. Oireachtas Grants:

   Income under this heading is the actual cash received in the period of the Account.

3. Fixed Assets:

   Fixed Assets comprise the furniture, equipment, computers and motor vehicles of the Institute and are shown at cost less accumulated depreciation.

   The rates of depreciation, calculated on a straight line basis, are as follows:-

Furniture and Equipment	10%
Computers	25%
Motor vehicles	25%

   Premises occupied by the Institute are leased from the Office of Public Works.

4. Capital Reserve:

The capital reserve comprises income allocated for the purchase of fixed assets. It is written down in line with the depreciation of the related assets.

5. Library:

Expenditure on library books and materials is charged to the Income and Expenditure Account. The current value of such books and materials is estimated at £470,000.

6. Publications:

Expenditure on publications is written off in the year in which it is incurred. The estimated value of such publications on hand at 31 December 1992 was £747,638.

7. Superannuation:

All superannuation benefits to or in respect of employees of the Institute, under its superannuation schemes, are met out of grants in the year of payment. Contributions in respect of these schemes are netted against salaries charged in the Account. No provision is made in these accounts for future benefits.

Income and Expenditure Account for the year ended 31 December 1992

1991		1992
£		£
	Income	
2,250,000	Oireachtas Grant	2,483,000
37,627	Sales of Publications	35,085
-	Celtic Studies Fees	3,250
169,186	School of Cosmic Physics (Note 4)	103,537
39,506	Miscellaneous (Note 9)	59,627
	Profit on disposals	748
2,496,319		2,685,247
(24,980)	Transfer from Capital Account (Note 6)	12,725
2,471,339		2,697,972
	Expenditure	
599,314	School of Celtic Studies	571,724
315,047	School of Theoretical Physics	314,572
1,013,276	School of Cosmic Physics	1,074,468
537,817	Administration	554,187
128,965	Depreciation (Note 5)	84,968
2,594,419		2,599,919
(123,080)	**Surplus (Deficit) for year**	98,053
229,088	Balance at 1 January	106,008
106,008	Balance at 31 December	204,061

The Accounting Policies, Notes 1 to 10 and Statement form part of these accounts.

CHAIRMAN - COUNCIL OF THE INSTITUTE

Balance Sheet at 31 December 1992

1991				1992
£	£		£	£
246,250		Fixed Assets (Note 5)		233,525
		Current Assets:		
	216,849	Cash on Hands and at Bank	346,907	
327,755	110,906	Debtors and Prepayments	85,155	432,062
574,005		TOTAL ASSETS		665,587
		Current Liabilities:		
	194,437	Creditors and Accruals (Note 2)	198,341	
221,747	27,310	Funds (Note 1)	29,660	228,001
352,258		Net Assets		437,586
		Financed by:		
106,008		Surplus Income and Expenditure Account		204,061
246,250		Capital Reserve (Note 6)		233,525
352,258				437,586

The Accounting Policies, Notes 1 to 10 and Statement form part of these accounts.

CHAIRMAN - COUNCIL OF THE INSTITUTE

Cash Flow Statement
for the year ended 31 December 1992

1991	1991		1992	1992
£	£		£	£
(9,812)		Net Cash Flow from Operating Activities (Note 7)		153,738
		Returns on Investments and Servicing of Finance		
38,759		Interest Received		47,815
28,947		Net Cash Flow from Operating Activities and Returns on Investments		201,553
		Investing Activities		
	(153,945)	Purchase of Fixed Assets	(72,386)	
	0	Sale of Fixed Assets	891	
(153,945)		Net Cash Outflow from Investing Activities		(71,495)
(124,998)		Increase (Decrease) in Cash and Cash Equivalents		130,058

Statement 1

Detailed Analysis of Income and Expenditure
for the year ended 31 December 1992

INCOME	School of Celtic Studies	School of Theoretical Physics	School of Cosmic Physics	Adminis-tration	Total	1991 Total
	£	£	£	£	£	£
Oireachtas Grants	571,100	321,600	1,021,100	569,200	2,483,000	2,250,000
Sales of Publications	35,061	0	24	-	35,085	37,627
School of Celtic Studies (RIA)	3,250	-	-	-	3,250	-
School of Cosmic Physics (Note 4)	-	-	103,537	-	103,537	169,186
Miscellaneous (Note 9)	394	0	11,446	47,787	59,627	39,506
Profit on disposals					748	0
	609,805	321,600	1,136,107	616,987	2,685,247	2,496,319
Transfer from Capital Account (Note 6):						
Allocated for Capital purposes	(12,020)	(5,102)	(49,979)	(5,285)	(72,386)	(153,945)
Amount released on disposals	-	-	-	-	142	0
Amortisation in line with asset depreciation					84,968	128,965
	597,785	316,498	1,086,128	611,702	2,697,971	2,471,339
EXPENDITURE						
Salaries, Wages and Superannuation (Note 10)	408,517	209,468	805,290	292,494	1,715,769	1,529,806
Scholarships	44,968	50,685	37,406	-	133,059	113,211
Honoraria	75	250	500	-	825	1,970
Library (incl. Microfilms)	34,289	31,896	26,434	-	92,619	82,652
Publications	44,763	949	676	1,196	47,584	81,441
General Administration (Note 3)	-	-	-	218,858	218,858	238,074
Travel and Survey Expenses	3,921	6,124	53,868	1,472	65,385	71,852
Symposia & Seminar Expenses	1,579	1,674	-	-	3,253	2,795
Equipment: Consumable & Maintenance	-	-	21,511	-	21,511	34,440
Special Commitments and Projects	3,250	-	100,378	-	103,628	175,416
General Expenses	30,362	13,526	28,404	40,167	112,459	133,797
	571,724	314,572	1,074,467	554,187	2,514,950	2,465,454
Depreciation (Note 5)					84,968	128,965
					2,599,918	2,594,419
SURPLUS (DEFICIT) FOR YEAR	26,061	1,926	11,661	57,515	98,053	(123,080)
Balance at 1 January 1992	4,732	(5,656)	33,545	73,387	106,008	229,088
Balance at 31 December 1992	30,793	(3,730)	45,206	130,902	204,061	106,008

NOTES TO THE ACCOUNTS

1. Funds:

These comprise:	Vernam Hull Bequest	28,073
	Carmody Fund	1,587
		29,660

The funds are held on deposit.

2. Creditors and Accruals:

Included in this heading is £4,606 contract research monies unexpended at 31 December, 1992, which is credited to revenue in line with expenditure on projects (Note 4).

3. General Administration Expenses:

Rent, Rates & Insurance	87,402
Premises Maintenance	26,592
Postage & Telephones	61,440
Fuel, Light & Power	34,990
Sundry Supplies	8,434
	218,858

4. School of Cosmic Physics - Research Programmes and Fees:

Project	Contributor	Opening Balance	Income	Applied	Unexpended
		£	£	£	£
Seismic Survey at Carnsore	ESB	-	300	300	-
HOGS	EOLAS/Riofinex	-	2,500	2,500	-
BGS/Transfrontier	BGS	-	355	355	-
ISOPHOT	ESA	-	36,545	36,545	-
RAPIDS	EOLAS	17,621	5,404	20,273	2,752
ICRC	Delegates Subs	-	9,840	9,840	-
La Palma	Eolas	-	2,500	2,500	-
EADN	Stockholm Univ. et al	-	4,205	4,205	-
Low Mass Star	EOLAS	5,993	6,650	10,789	1,854
IRMA	European Commission	-	7,203	7,203	-
LDEF	EOLAS	-	3,470	3,470	-
Other Fees	Various	-	5,556	5,556	-
		23,614	84,528	103,536	4,606

5. Fixed Assets

	Furniture & Equipment	Motor vehicles	Computers	Total
Cost	£	£	£	£
Opening Balance 1/1/92	536,703	17,575	562,292	1,116,570
Additions	9,785	3,411	59,190	72,386
	546,488	20,986	621,482	1,188,956
Disposals	(1,043)	(7,075)	0	(8,118)
	545,445	13,911	621,482	1,180,838
Depreciation				
Opening Balance 1/1/92	415,480	9,700	445,140	870,320
Charge 1992	25,965	4,331	80,388	110,684
*Adjustment 1992			(25,716)	(25,716)
	441,445	14,031	499,812	955,288
Depreciation on disposals	(900)	(7,075)	0	(7,975)
	440,545	6,956	499,812	947,313
Net book value 31/12/92	104,900	6,955	121,670	233,525
Net book value 31/12/91	121,223	7,875	117,152	246,250

* **Note:** The 1990 provision for depreciation was overstated and has been adjusted in these accounts.

6. Capital Reserve:

Balance at 1 January, 1992		246,250
Transfer to Income and Expenditure Account		
Income allocated for capital purposes	72,386	
Amortisation in line with asset depreciation	(84,968)	
Amount released on disposals	(143)	(12,725)
Balance at 31 December, 1992		233,525

NOTES TO THE ACCOUNTS (Cont.)

7. (a) **Reconciliation of Surplus/(Deficit) for the year to Net Cash Flow from Operating Activities**

1991		1992
(123,080)	Surplus/(Deficit) per Income & Expenditure	98,053
	Adjustment for Non-Operating Items:	
(38,758)	Interest	(47,815)
-	Profit on Disposal	(748)
24,980	Movement on Capital Account	(12,725)
(136,858)		36,765
	Adjustment for Non-Cash Items:	
128,965	Depreciation Charges	84,968
8,135	Decrease in Debtors	25,751
(10,054)	Increase/(Decrease) in Creditors & Funds	6,254
(9,812)	Net Cash Flow from Operating Activities	153,738

(b) **Analysis of Cash and Cash Equivalents and Movements During the Year**

341,847	Balance at 1 January	216,849
(124,998)	Net Cash Flow	130,058
216,849	Balance at 31 December	346,907

8. **Leasing:**

(a) Operating Leases:

The premises occupied by the Institute are leased from the Office of Public Works. The commitment on foot of such leases in respect of 1993 is £43,725.

(b) Finance Leases:

There were no appreciable finance leases in existence at 31 December, 1992.

9. **Miscellaneous:**

Included in Miscellaneous is Bank Interest earned of £47,815 (1991 - £38,759) for the year.

10. **Superannuation:**

The total superannuation payments in the year amounted to £254,520. The salaries and superannuation charge in the accounts is net of contributions totalling £26,060.

Dublin Institute for Advanced Studies

Report of the Comptroller and Auditor General

I have examined in accordance with auditing standards the Accounts set out on pages 1 to 10 which are in the form approved under the provisions of the Institute for Advanced Studies Act, 1940. I have obtained all the information and explanations which I considered necessary for the purpose of my audit.

In my opinion proper books of account have been kept by the Institute and the Accounts, which are in agreement with them, give a true and fair view of the state of the Institute's affairs at 31 December 1992 and of its transactions and cash flow for the year then ended.

P.L. McDonnell

Comptroller and Auditor General

2 September 1993